# Managing Sustainable Development
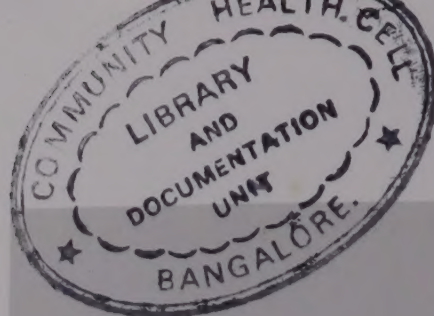
Experience from Preparation of an
Environmental Management Plan for
Dakshina Kannada District, India

## Abbreviations and Acronyms

| | |
|---|---|
| BOD | Biochemical Oxygen Demand |
| $CO, CO_2$ | Carbon Monoxide, Carbon Dioxide |
| CPUE | Catch Per Unit Effort |
| CWC | Central Water Commission |
| DEC | District Environmental Committee |
| DFEE | Department of Forest, Ecology and Environment |
| DK | Dakshina Kannada |
| DLUP | District Land Use Plan |
| DMG | Department of Mines and Geology |
| DPC | District Planning Committee |
| EEZ | Exclusive Economic Zone |
| EIA | Environmental Impact Assessment |
| EMP | Environmental Management Plan |
| EMPS | Environmental Master Plan Study |
| ES | Ecosystems |
| ha | Hectares |
| HDI | Human Development Index |
| IMR | Infant Mortality Rate |
| I-5 | Intervention No.5  (The intervention no. refers to the full list of interventions on the last pages) |
| KEB | Karnataka Electricity Board |
| KIADB | Karnataka Industrial Area Development Board |
| KIOCL | Kudremukh Iron Ore Company Limited |
| KREC | Karnataka Regional Engineering College |
| KSPCB | Karnataka State Pollution Control Board |
| KUWS&DB | Karnataka Urban Water Supply & Drainage Board |
| LUP | Land Use Plan |
| mcm | Million Cubic Meters |
| MCC | Mangalore City Corporation |
| mgd | Million Gallons per Day |
| MRPL | Mangalore Refinery and Petrochemicals Limited |
| MUDA | Mangalore Urban Development Authority |
| NBSS&LUP | National Bureau of Soil Survey and Land Use Planning |
| NDDP | Net District Domestic Product |
| NGO | Non Government Organization |
| NMPT | New Mangalore Port Trust |
| $NO_x$ | Nitrogen Oxides |
| NR | Natural Resource |
| NWFP | Non-Wood Forest Products |
| Pb | Lead |
| Rs | Rupees |
| SC | Scheduled Castes |
| SD | Sustainable Development |
| $SO_2$ | Sulphur Dioxide |
| SPM | Suspended Particulate Matter |
| ST | Scheduled Tribes |
| ZP | Zilla Panchayat |

# Contents

# Preface

## Background

In 1989, the Government of India requested the Danish Government to assist the Department of Forest, Ecology and Environment, Karnataka State in preparing an Environmental Management Plan for Dakshina Kannada District. As an outcome from this request, an Environmental Master Plan Study was initiated in January 1993.

Dakshina Kannada was targeted for this study because it is projected that industrial and urban growth in this District will increase dramatically over the next decade and that agricultural ventures will continue to expand into marginally productive areas. While these developments will lead to more employment opportunities and some welfare benefits for the citizenry, there are concerns about long-term impacts on the District's natural resources and ecological systems. These environmental concerns have been expressed both by government agencies and local citizen groups.

The Environmental Management Plan, which is an output from the Environmental Master Plan Study, consists of a framework and actions for ensuring that development activities take place without harming the environment. The Environmental Management Plan spells out specific actions to be taken by local and state institutions to ensure that district development proceeds in a sustainable manner. The actions are framed within the context of 21 groups of interventions which collectively focus on the following strategies: institutional capacity building and multi-sectoral cooperation; introduction of new techniques and methodologies; and raised environment consciousness of the public. Each of the interventions are equally important and essential to successful implementation of the Environmental Management Plan and for ultimately attaining the long-term objective of sustainable development in the District.

The following is a more detailed description of the interventions. Similar interventions will probably be needed to achieve sustainable development in other districts.

## Interventions

### Strengthening Institutional Capacities Including Regulatory and Enforcement Systems.

The interventions will help institutions responsible for environmental planning and protection to carry out the activities detailed in the Environmental Management Plan. Training and human resources development are an important component of these interventions. Economic instruments, focused on conserving natural resources and ecosystems, are also suggested as part of these interventions.

### Monitoring and Management of Natural Resources and Ecosystems.

These interventions will ensure that natural resources and ecosystems in the District will be continuously monitored through sampling and analysis of selected parameters and indicators. To complement monitoring, a number of management plans for specific natural resources and ecosystems are suggested, along with analytical tools for modelling and predicting environmental impacts.

### Land Use Planning.

A key intervention is the preparation of a District Land Use Plan based on land capability assessment and sound planning techniques. It is envisioned that a District Land Use Plan will be a decisive mechanism for determining how urban and rural development, including planning of major infrastructures delineation of urban/rural interfaces, can take place with minimum adverse impact on the environment. A support tool to land use planning is the Environmental Impact Assessment - a process for evaluating whether proposed large-scale industries and major infrastructure are compatible with the long-term sustainable development objectives of the District.

### Environmental Management of Sectors Affecting Natural Resources and Ecosystems.

These interventions consist of management plans for Industrial Pollution Control, including pollution prevention, waste reuse and recycling, and cleaner technologies. Another sectoral management plan for energy focuses on environmentally friendly measures such as conservation and utilization of non-conventional and renewable energy systems. A Traffic Management Plan offers strategies for reducing both traffic congestion and polluting air emissions from vehicles.

### Renovation and Clean-up Programmes.

These interventions are directed towards sectors where environmental problems are already evident and there is a critical need for immediate response. Detailed clean-up and renovation programmes are proposed for two critical sectors in the District - sanitation and solid waste systems in larger urban areas.

## Public Awareness and Participation Programme.

To achieve success, all the recommended interventions require some degree of public support and commitment, either in intervention planning, implementation or monitoring. To ensure that public input is meaningful and supportive to the Environmental Master Plan process, public awareness campaigns and environmental education programmes will be used to raise public awareness and to cultivate a sense of civic responsibility in conserving and protecting the environment.

## The Brochure

This brochure outlines the methodology of the Environmental Master Plan Study as well as the major findings and recommendations. It is intended that this brochure will inspire other districts, within and outside Karnataka, to undertake similar studies and plans. It is further foreseen that this brochure will contribute to a better understanding of environmental issues and problems and the need to solve these problems through integrated sectoral planning.

The responsibility for protecting the environment lies not only with the government, but also with the general public, citizen groups, professional organizations and knowledgeable institutions. To promote this concept, the Environmental Management Plan and this brochure can show the possibilities for a workable environmental partnership between government institutions, the public and independent organizations.

*The EMPS Team*
*Mangelore, December 1994*
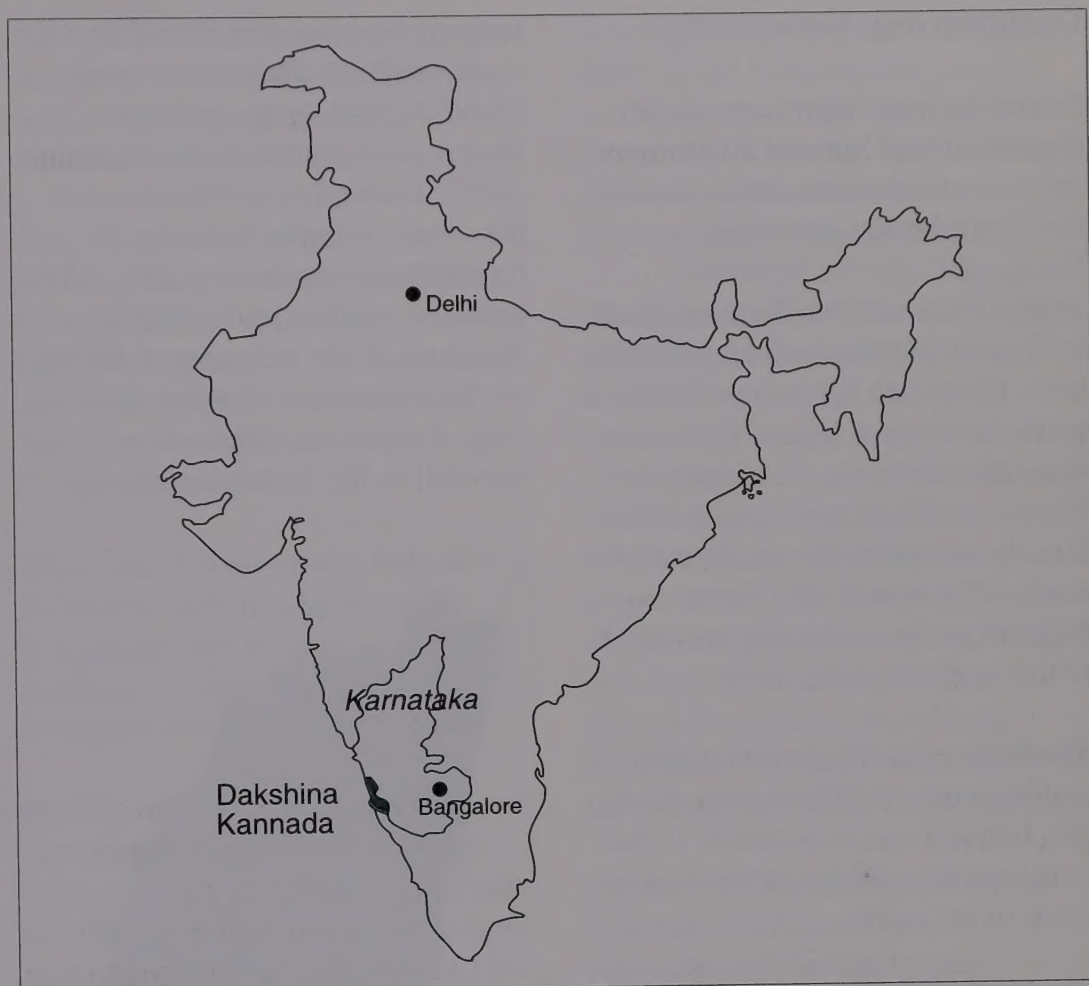


*Map of India.*
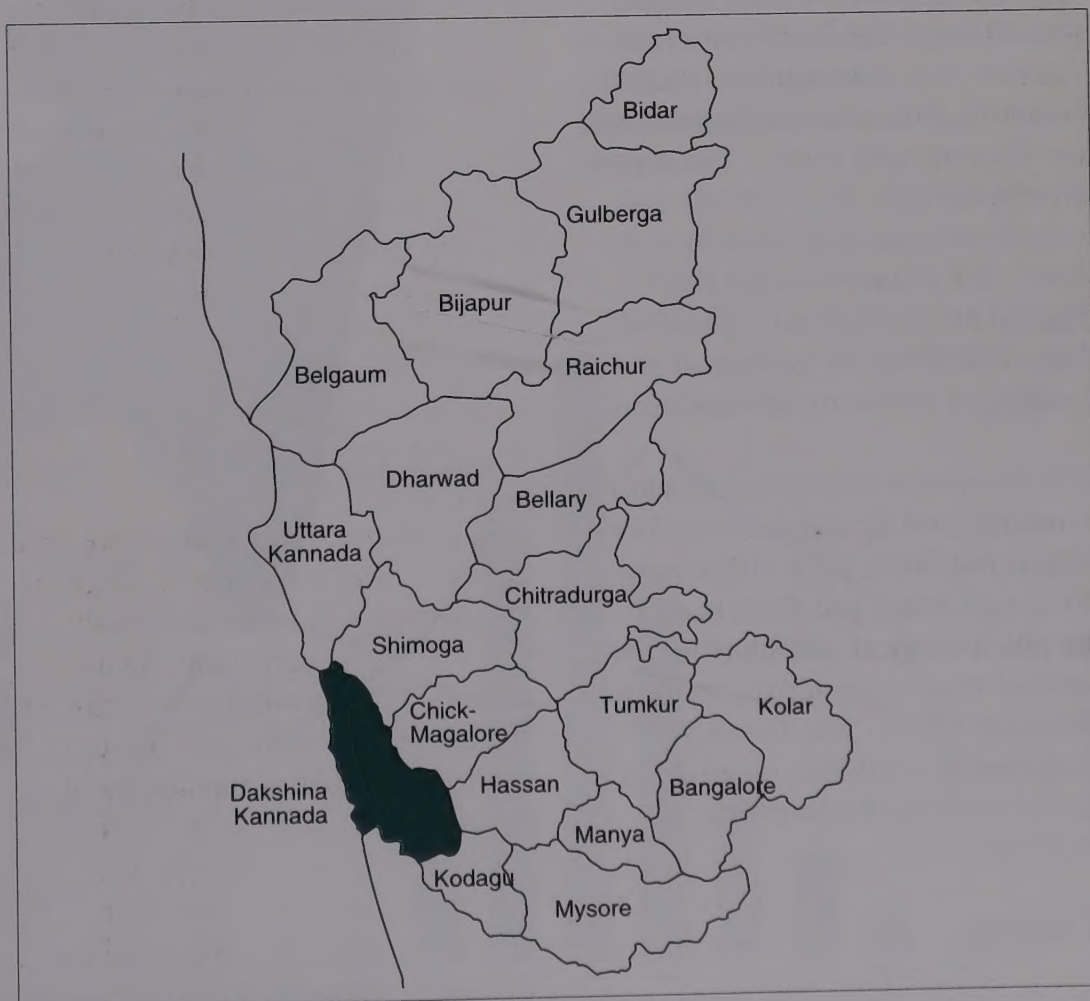


*Map of Karnataka State.*

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# Dakshina Kannada District at a Glance

### Location and Geography

Dakshina Kannada is one of 20 districts of the State of Karnataka and is located on the west coast of the South Indian peninsula. Geographically, the District is wedged between the Western Ghats to the east and the Arabian Sea to the west. Dakshina Kannada is bounded by the districts of Uttara Kannada to the north, Shimoga, Chickmagalur, Hassan and Kodagu to the east and Kasargod taluk of Kerala State to the south. The area of the District is 833,595 hectares, constituting 4.4 % of the total area of the State.

The District is 177 km in length and has about 135 km of coastline. The breadth varies between 10 km in the north to 80 km at the widest point in the south.

Twenty-two west-flowing rivers, originating in the Western Ghats, flow through the District into the Arabian Sea. Netravathi, Gurpur, Gangolli, Sitanadi and Swarnanadi are the principal rivers. The rivers have relatively short courses and experience seasonal variations in flow. Six estuaries in the river system are considered particularly important from an ecological and biological productivity standpoint.

The District is well-forested and is characterized by a rich diversity of fauna and flora. Five major types of forests exist, and there is a greater variety of plant and animal species than in most regions of the Western Ghats. The District contains two wildlife sanctuaries and part of the Kudremukh National Park.

### Climate

The weather is hot and humid for most of the year and humidity exceeds 85%. The period from March to May is the summer season with temperatures reaching 35°C. December to February are the winter months with day temperatures averaging 23°C. The annual rainfall is about 4400 mm. The bulk of the rain occurs during the four monsoon months of June, July, August and September. Rainfall in the District is almost four times greater than the average for the State. The District has a unique meteorological regime dominated by sea-land breezes.

### Population

The district population, as per the 1991 census, is 2.69 million, compared to 2.37 million in 1981. Population density is high at 319 per square km, compared to the
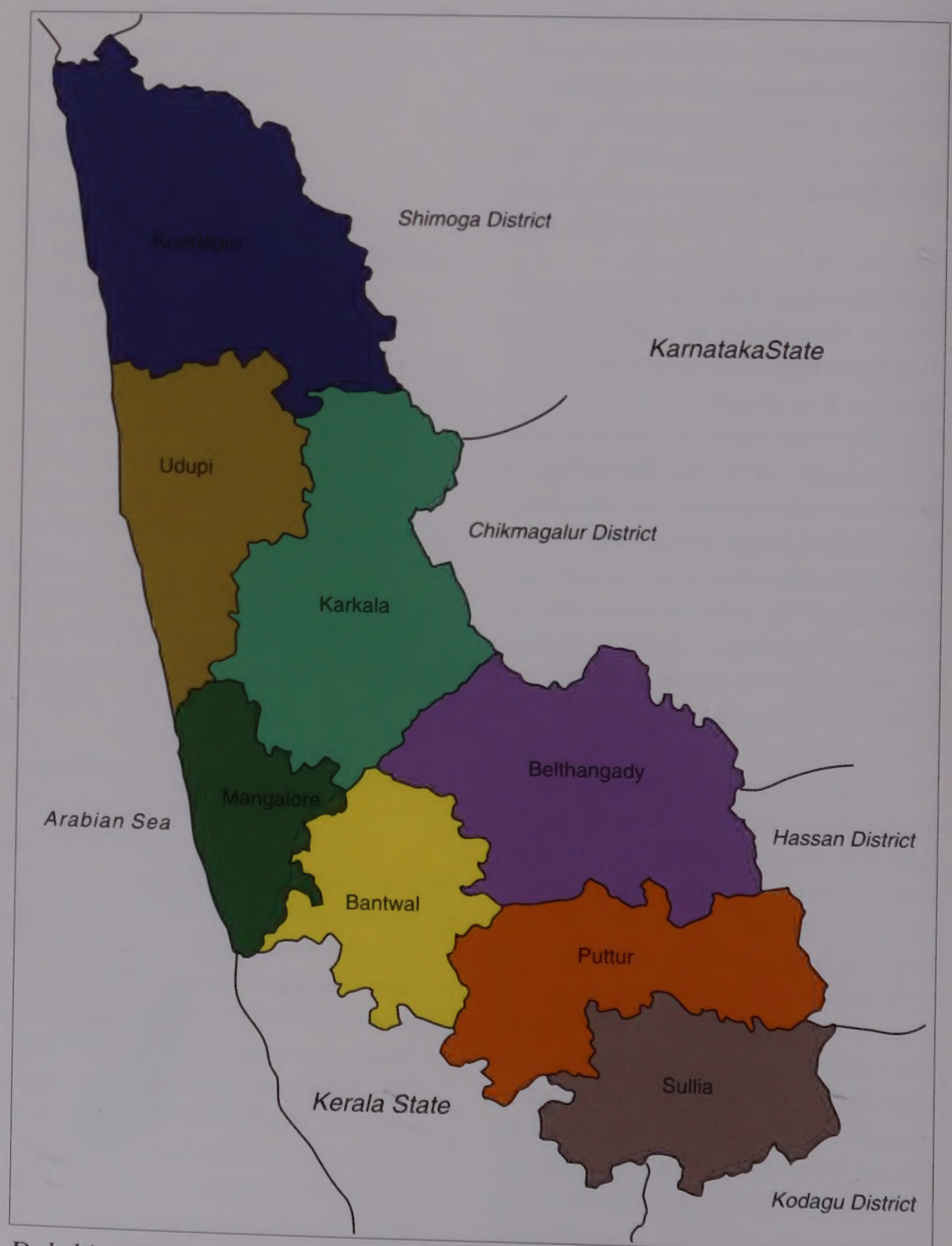


*Dakshina Kannada District, the Project Area of the Environmental Master Plan Study.*

state average of 234. The biggest towns are Mangalore with 469,500 inhabitants and Udupi with 146,000.

## Infrastructure

The District has a deep-sea, all weather port near Mangalore. In addition, there are fishing harbours situated in Mangalore and near Malpe. National Highway 17, which connects Kanyakumari to Bombay, runs through the District along the coast line, and National Highway 48 connects Mangalore with Bangalore. The Konkan Railway, connecting Mangalore to Bombay, is in progress. Mangalore is served by a small airport with daily flights to Bombay and regular flights to Bangalore.

## Administration

Dakshina Kannada is sub-divided into 8 taluks: Bantwal, Belthangady, Kundapur, Karkala, Mangalore, Puttur, Sullia and Udupi. There are 688 villages in the District.

District administration is carried out by two government bodies, namely the office of the Deputy Commissioner and the Zilla Panchayat. The Deputy Commissioner is responsible for revenue collection and law and order in the District, whereas the Zilla Panchayat oversees development activities in the rural areas.

Mangalore City Corporation (MCC), the Municipality of Udupi and 10 Town Municipal Councils are all governed by elected bodies and are responsible for providing urban services. Elected bodies are also soon expected to be in place at village level (Gram Panchayat), at taluk level (Taluk Panchayat), and at district level (Zilla Panchayat), which will replace the Zilla Parishad.

The Mangalore Urban Development Authority (MUDA) is responsible for land use planning and development in the Mangalore area, and Udupi Town Planning Authority has similar duties in the Udupi-Malpe area.

There are two territorial Forest Divisions with headquarters in Mangalore and Kundapur. In addition, a wildlife division has its headquarters in Karkala.

State level autonomous bodies provide selected services to the District. These institutions include the Karnataka Urban Water Supply and Drainage Board (KUWS&DB) - construction of water supply and drainage systems; Karnataka Electricity Board (KEB) - electricity supply; and Karnataka Industrial Area Development Board (KIADB) - land procurement for industrial development. Furthermore, State and Central Government public sector undertakings, such as the Telephone Authority and the Port Authority, influence the development of the District.

The Department of Forest, Ecology and Environment (DFEE) is the nodal agency at the state level responsible for the protection of the environment. In coordination with DFEE, Karnataka State Pollution Control Board (KSPCB) has responsibility for the enforcement of various provisions of the Water Act, the Air Act, the Environmental Protection Act and the Hazardous Wastes Rules. KSPCB has a regional office in Mangalore.

Mangalore University, the Fisheries College of the Agricultural University and Karnataka Regional Engineering College (KREC) are local institutions which have expertise in a variety of fields within environmental research and education.
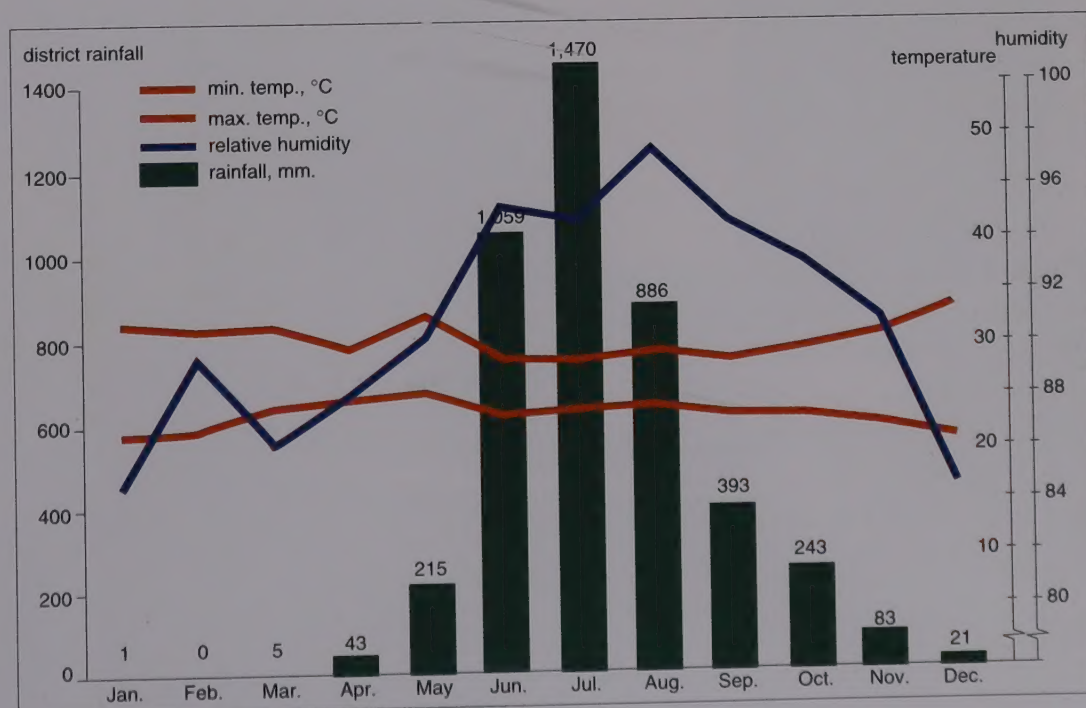


*Weather Conditions in Dakshina Kannada.*

# Why and How to Prepare an Environmental Management Plan

## Background

Rapid industrial development, population growth and significant change in land use will place considerable stress on natural resources and ecological systems in Dakshina Kannada. Some of the natural resources and ecosystems are already in a state of critical exploitation. Consequently, there is an urgent need to develop environmental planning tools to influence the development process so that natural resources are not depleted and rich ecological systems are not destroyed. Healthy social and economic development - the quality of life - depends both on maintaining adequate stocks of good quality natural resources and on preserving biodiversity through well-functioning ecosystems.

Similar development issues are found in other districts in Karnataka, so there is a wide-ranging need for environmental management planning throughout the State.

## Objectives of the EMPS

The long-term objectives of the Environmental Master Plan Study (EMPS) are:

- integrated management of natural, human and economic resources in Dakshina Kannada District by year 2002;
- to measurably move towards sustainable development in the District, and
- to facilitate the introduction of integrated environmental management in other districts.

To support these objectives, an Environmental Management Plan for Dakshina Kannada, including action plans for involved agencies and institutions, will be prepared.

An important EMPS function is to increase environmental knowledge and awareness among involved agencies and institutions and the public in general, and to strengthen public participation in the environmental planning process.

*Development activites in the District must be properly managed to prevent depletion of natural resources and damage to ecological systems on which social well-being depends.*

## The Principle of Sustainable Development

For the EMPS, sustainable development is defined in terms of three major elements:

- Continuous availability of natural resources, and
- Maintaining ecosystems intact over time, so that
- Socio-economic welfare goals can be achieved.

## Sustainability of Natural Resources and Ecosystems

**Natural Resources.**
In Dakshina Kannada, important natural resources include agricultural land, reserved forests and common lands, ground water, surface water, fish, minerals and air. These natural resources may serve at least one or more of the following functions:

- As a *producer* for providing essential raw materials and inputs for urban, industrial and rural development.

- As a *recipient* for transporting and transforming waste products from human activities. If waste quantities or characteristics exceed the natural cleansing capacity, the so-called carrying capacity, then the quality of the resource becomes unacceptable and damage may be irreversible.

- As a *life support mechanism* for providing essential amenities (e.g. clean air, water and food) and more indirect functions such as stabilization of local or regional climate patterns.

Quantity and quality, which are important characteristics of a natural resource, determine how well a resource is able to function in the roles of provider, recipient and life supporter.

**Ecosystems.**
Ecosystems are systems of plants and animals in an area. Particular attention is given to the complex interaction of the organisms with the physical surroundings and with each other.

In the District, the following ecosystems are especially important: those which make up the Western Ghats, including diverse flora and fauna; rivers and fresh water ecosystems; estuaries and tidal ecosystems, including mangrove areas; and marine ecosystems.

Ecosystems are closely related to natural resources and therefore often provide the same or similar functions. Unique functions of ecosystems include the following:

- Production of oxygen and consumption of carbon dioxide through photosynthesis
- Production of timber and non-wood products
- Fish production and food chain maintenance
- Protection of biodiversity.

## Achieving Socio-Economic Welfare Goals

To monitor achievement of socio-economic welfare goals, the EMPS used a Human Development Index (HDI) based on the index developed by the United Nations Development Programme (UNDP).



**Institutional Framework**

Economic Setting

Natural Resources and Ecological Systems

Use / Exploitation →

← Impact

Urban and Industrial Development including Major Infrastructure

and

Rural Development
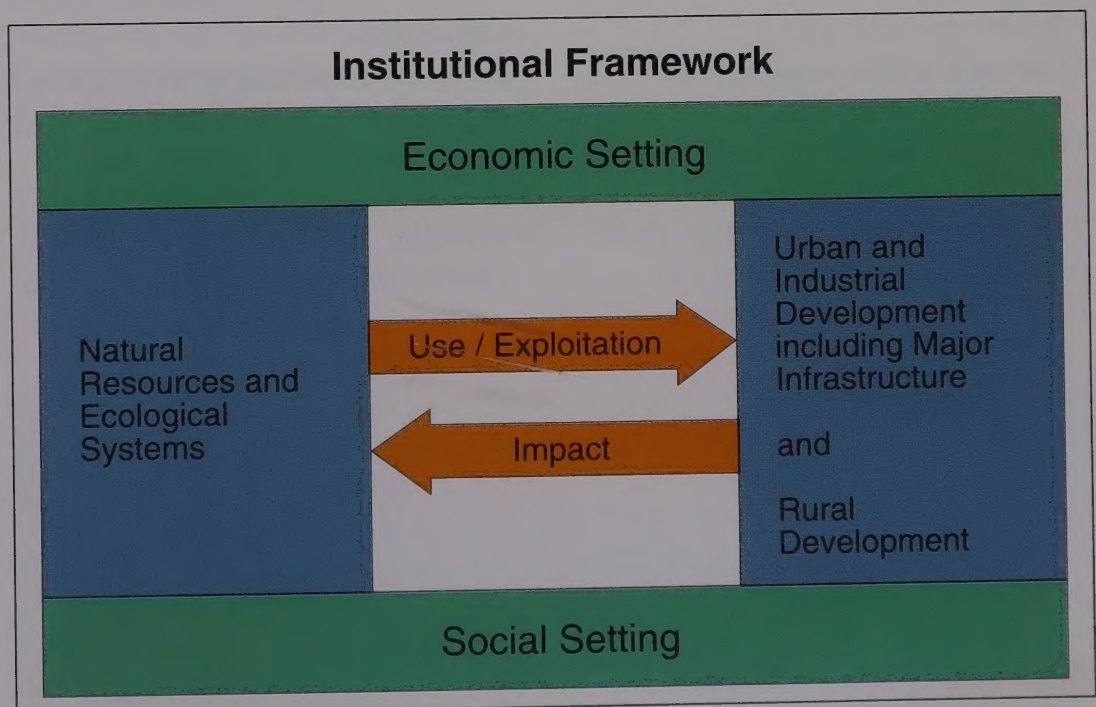
Social Setting

### Interrelationship between components of EMPS

The institutional framework and the economic and social settings influence and constrain production and consumption activities in the urban and rural sectors. Urban and rural activities use natural resources as raw material inputs and produce waste. Both uses have an impact on the quantity and quality of stocks of natural resources and on ecosystems.

# Why and How to Prepare an Environmental Management Plan

| Step 1 Assess state and trends of • Natural resources and ecosystems • Economic conditions • Social conditions | Step 2 Prepare development scenario | Step 3 Assess impact of projected development on natural resources and ecosystems | Step 4 Define long-term sustainable development objectives for natural resources and ecosystems | Step 5 Identify conflicting areas between development trends and objectives for natural resources and ecosystems | Step 6 Define long-term interventions necessary to achieve sustainable development objectives | Step 7 Assess capability of involved institutions to implement interventions |
|---|---|---|---|---|---|---|

Impact      Move towards Sustainable Development Objectives

| Step 12 Implement Action Plans | Step 11 Prepare environmental management plan and action plans | Step 10 Define short-term targets for natural resources and ecosystems | Step 9 Define short-term targets for interventions | Step 8 Strengthen institutional capacities |
|---|---|---|---|---|

*Environmental Management Planning Process.*

The HDI is based on the following parameters:
• Infant mortality rate
• Literacy and primary school enrolment ratio
• Per capita income.

The socio-economic welfare goals of society can only be met by future generations if natural resources and ecological systems remain available and are of good quality.

Supporting factors for achieving socio-economic goals include adequate basic services such as health and education, efficient systems of resource allocation, etc.

## Main Contents of the EMP

The Environmental Management Plan for Dakshina Kannada constitutes the environmental framework within which development activities can take place without harming the NR+ES.

The EMP contains the following:

• **Objectives**
Long-term sustainable development objectives for natural resources and ecosystems within the District.

• **Targets**
Descriptions of expected progress (or improved conditions) in 1997 and 2002 leading to sustainable development.

• **Interventions**
The wide range of actions required for achieving the targets in the move towards long-term sustainable development objectives.

• **Indicators**
Well-defined facts, qualities, or situations to measure whether the interventions are accomplishing the desired targets.

• **Responsibility**
Agencies and institutions responsible for the EMP implementation.

• **Schedule and Funding**
Time schedule for the EMP implementation including costs and funding strategies.

• **Monitoring**
Methods for monitoring effectiveness of the EMP implementation

## Preparation of the EMP and Action Plans

**Step 1**
The starting point consists of an in-depth assessment of existing conditions and trends in the District for:
• industrial, urban and rural development;
• economic and social conditions;
• institutional responsibilities and capacities; and
• status of natural resources and ecosystems.
All analyses are based on existing and readily available data.

**Step 2**

From the analysis and conclusions in Step 1, a development scenario for the District is drawn. This scenario presents a predicted coherent picture of future development and conditions without an EMP in place. The scenario is formulated in terms of *Parameters* which describe a development component (e.g., industrial production, net district domestic product, population, etc.); and *Factors* which influence the parameters. For example, factors influencing industrial production are government policy and availability of electricity. Factors play a key role in structuring interventions and controlling the future trend of a parameter. *Trends* are projections which describe the status of a parameter at a particular point in the future. Examples of trend statistics include number of industrial production units, net area under cultivation, total employment per sector, etc.

**Steps 3 and 4**

The impact of the projected development scenario from Step 2 is assessed in terms of future environmental impact on natural resources and ecosystems. In addition, long-term sustainable development objectives for each natural resource and ecosystem in the District are defined. Indicators for describing the state of the natural resources and ecosystems are also defined. These indicators provide the mechanism for making comparisons between the current and predicted status of the natural resources and ecosystems, and the long-term sustainable development objectives.

**Step 5**

Present and potential problem areas are identified by analyzing where existing and future development are in conflict with the objectives for natural resources and eco-systems. This analysis indicates the extent to which the natural resources and ecosystems are or will be under pressure.

**Step 6**

A wide range of activities are recommended to address the problem areas identified in Step 5. Estimates of costs and benefits of the interventions are made.

**Steps 7 and 8**

The institutions and agencies responsible for administering and implementing the interventions are assessed with regard to ability or capacity to perform the required actions. In cases where institutional deficiencies and constraints are found, appropriate measures to strengthen the institutions will be formulated and, to the extent possible, implemented.

**Steps 9 and 10**

Targets for interventions, which are realistic to achieve by 1997 and 2002, are identified, considering the realistic institutional strengthening, and the targets for natural resources and ecosystems.

**Steps 11 and 12**

The EMP and the corresponding Action Plans for participating institutions and agencies are prepared and implemented.

After 3 to 5 years, the EMP and the Actions Plans should be reviewed and revised, if necessary, following the same cycle as indicated above.

It is envisaged that the EMP process is implemented with a high degree of public participation. The public is to be involved in reviewing and commenting on draft plans and represented at key meetings and hearings.



*View of The Western Ghats.*

## Industrial Development

### Present Industrial Situation

Historically, the predominant industries in the District have been associated with agriculture and fisheries. This traditional industrial base began to change in 1976 with the opening of the New Mangalore Port. The Port led to the establishment of several large-scale industries. Currently, there are 9 large-scale, 34 medium-scale, and approximately 9,000 small-scale industries in the District.

### Planned Industrialization

Within the next few years, significant growth in industrial production and infrastructure development is expected to occur in the District. Large-scale industries now under construction in the Mangalore area include an oil refinery and a chemical factory. Other large industrial projects are under consideration. A few existing industries are planning to double their outputs. New infrastructures include the Konkan Railway connecting Mangalore to Bombay, the expansion of the New Mangalore Port, and possibly a 1000-MW thermal power plant. The new industries and infrastructures are likely to stimulate growth in downstream industries.

### Potential Environmental Impact

While the expected rapid industrilization will lead to certain income and employment opportunities, there is concern about its long-term impact on the environment. Availability of natural resources and the ability of the environment to assimilate waste loadings are factors that need to be taken into account when planning new industries. Of critical concern to the District is whether there will be

sufficent freshwater all year to supply large industrial consumers and still meet the demands of the urban and rural communities. Industrial wastewater discharges to rivers and estuaries will also be of concern since the carrying capacities of these resources are uncertain.

Also, studies and increased monitoring will be required to determine whether toxic materials and heavy

metals will present a threat to sensitive ecosystems and the likelihood of these substances entering the food chain. Toxic materials and heavy metals may be discharged directly to the marine environment through offshore pipelines. These harmful materials may also enter rivers and estuaries as a result of leaching or run-off from industrial waste piles and raw material storage areas. The impact of cumulative air emissions, from
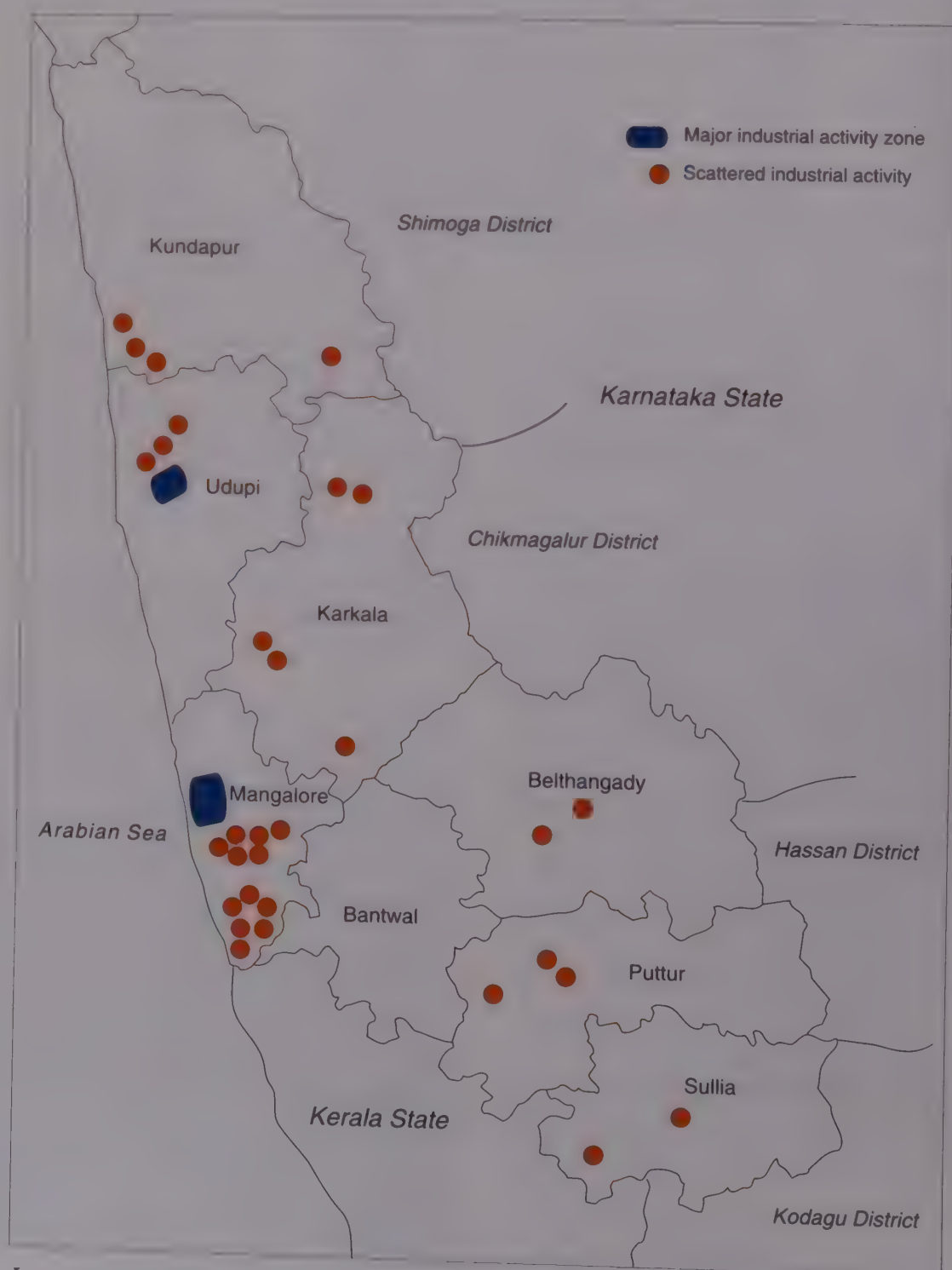


*Location of major industries in Dakshina Kannada.*

both domestic and industrial sources, on the ecology of the fragile Western Ghats is also a critical issue.

By 2002, the following industrial scenario is expected:

- pollution emissions to air from large-scale industries alone may increase by a factor of 9;

- wastewater discharges may increase by a factor of 4;

- generation of industrial solid and hazardous wastes could increase by about 14 million tonnes per year;

- freshwater demand will expand from 13 to about 53 mgd; and

- about 2,000 ha of picturesque rural land and hillocks in Mangalore taluk, extending from the Gurpur Estuary to uplands near the airport, will be transformed into an industrial corridor.

Also by 2002, the number of industrial units in the District is estimated to be as follows :

- 17,000 small-scale
- 60-80 medium-scale
- 17+ large-scale.

**Interventions**
The interventions necessary to ensure that industrial development will not be harmful to the natural resources and ecosystems are listed under the respective natural resources and ecosystems.

**Occupational Health and Safety**

An improvement of working conditions in all industrial sectors is needed.

**Intervention**
The following intervention is proposed :

**I 19**: Strategies for Strengthening Occupational Health and Safety.



*MRPL  site before construction works started.*



*MRPL work in progress.*

## Urban Development

### Urban Areas and Future Development

The main urban areas in the District are clustered around Mangalore and Udupi, and over 75% of the urban population is situated in or near these two cities. In 1991, the population of Mangalore, Udupi and other urban centres was about 763,000 which constitutes around 28% of the District's population. By 2002, it is estimated that about 35% (1,125,000 persons) will reside in urban areas, as it is projected that people will continue to migrate from rural to urban areas.

### Urban Infrastructure and Environmental Issues

**Water Supply**
In the future, it is likely that urban areas and large-scale industries will be competing for limited supplies of freshwater, particularly during the dry months. Urban demand for freshwater in the District will increase moderately while industrial demand will escalate rapidly. In 1991, urban areas consumed about 22.5 mgd water as compared to 13 mgd for industry. By 2002, this water distribution pattern is expected to change radically; urban demand will be about 30 mgd and industrial demand about 53 mgd. This means that industrial demand will increase at a rate ten times greater than urban demand. It is not clear from whence the additional 40 mgd for industry will

come. Since most of the large-scale industries are planned for the Mangalore area, availability of freshwater supplies will be most critical in the Gurpur and Netravathi watershed areas.

**Wastewater and Sanitation**
The underground drainage and sewage treatment systems in Mangalore and Udupi are overloaded, out-dated or ineffectively utilized. Population increases will place further pressure on these systems and may cause them to fail, leading to human health hazards and the contamination of soil, ground and surface water. Cross- contamination of drinking water with untreated sewage is another potential problem, especially during power cuts when negative pressures may build up in the drinking water distribution



*Urban scene: Lack of pedestrian facilities. Autos and pedestrians have to share the roads.*

lines. During monsoon rains, the Mangalore sewage treatment system is rendered ineffective as excess drainage water enters and overloads the structures. Infiltration of contaminated rain water into the water distribution system can also occur.

### Solid Waste Disposal

Over the next decade, solid waste generation in the Mangalore urban area is expected to almost double. Similar trends are probable in the other urban centres. Existing urban solid waste management systems do not operate satisfactorily. In Mangalore, there is an insufficient number of collection bins, and the waste that is collected is often scattered by cows and other animals before municipal workers have a chance to clean the surroundings. The final disposal site is not well-managed and the exposed garbage breeds flies and other disease transmitting vectors. Relatively harmless domestic wastes are routinely mixed at the collection bins with infectious hospital wastes, which puts city sanitation workers and the general public at risk of contracting disease or encountering physical harm through contact with discarded scalpels and syringes. Besides the disease risk, there is a high potential for contamination of ground and surface waters as pollutants leach or run off from unmanaged waste piles.

### Energy Supply

Electricity shortage continues to be a state and regional problem. Power outages curtail the adequate functioning of water distribution, sewage treatment and collection systems. As a result, untreated sewage is often discharged directly to the environment.

### Traffic

By 2002, the volume of traffic in the District could increase by a factor of four, with the highest concentrations occurring in the Mangalore to Udupi corridor. A large amount of heavy truck activity is also expected to emerge between the New Mangalore Port and the industrial areas to the north of Mangalore. The current highway system and feeder routes are already too narrow and congested and future increases in traffic will not only create safety hazards but will also increase air pollution in the urban areas. People who work or spend time near busy urban intersections, such as Hampankatta in Mangalore, will be the most at risk from pollutants such as carbon monoxide, nitrogen oxides, suspended particulate matter and lead.

### Quality of Urban Life

The demand for residential housing in the urban areas will increase sharply to accommodate the population migrating to the cities. This new influx of people will likely increase land prices and induce further construction of multi-storey apartment blocks, which will further overload strained infrastructures. Current land use plans and responsible planning institutions are not capable of effectively handling new growth patterns and requirements. The demand for housing will also put pressure on open spaces that are needed for greenbelts, parks and recreational areas. With the intense demand for housing, the emergence of slums in Mangalore is a possibility. Quality of life in urban areas could deteriorate at an alarming rate, if appropriate measures are not taken.

### Interventions

The interventions necessary to ensure that urban development will not be harmful to the natural resources and ecosystems, are listed under the respective natural resources and ecosystems.
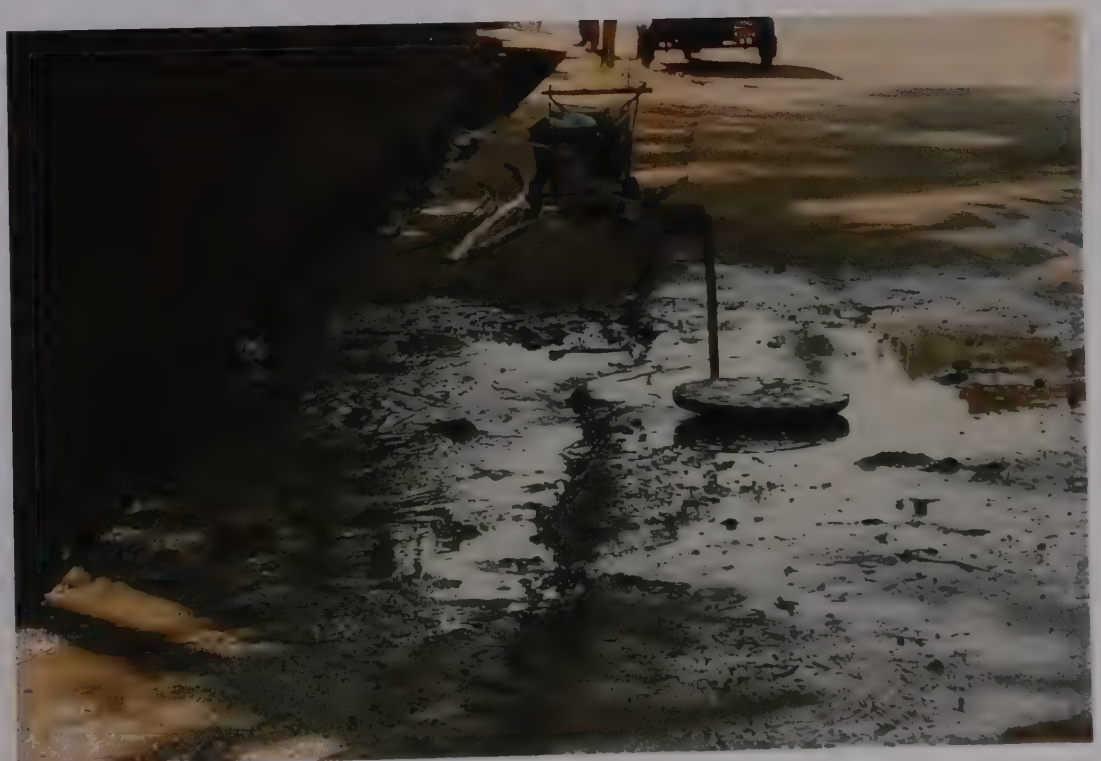


*The underground drainage system in Mangalore needs upgrading. Frequent blockings occur due to small dimensions and abuse by the traffic.*

## Rural Development

### Rural Areas and Future Development

There are currently over 600 villages in the District. Between now and 2002, it is estimated that the percentage of population in the District living in rural areas will decrease from 72% to around 65%. Even though there will be a general population shift from rural areas to urban centres, the overall population within the rural community will continue to increase, although at a smaller rate. An increasing rural population will continue to place stress on natural resources such as agricultural lands and common lands, and will lead to further encroachment on the common lands which are already exploited without any planning or management. This will lead to the destruction of areas of natural vegetation and important ecosystems. As common lands decrease, the poorer segment of the population will have to spend more time and effort to gather increasingly diminishing supplies of fuelwood, fodder and other land-based resources to maintain subsistence.

*Given the customary practice of dividing the family's landholding as a family grows, the size of individual agricultural holdings are decreasing. Each household then requires a suitable water supply, collection of fuelwood and leaf manure, which puts additional stress on natural resources.*

### Rural Industries

The District has a strong natural resource base to support the primary economic sector. Agriculture including animal husbandry and fisheries are by far the most important sub-sectors in terms of contribution to the total primary sector performance in the District. Other rural-based industries such as forestry, mining and quarrying contribute only marginally to the primary sector. Beedi-rolling and small cottage industries also create employment opportunities for rural people.

### Water Supply, Sanitation and Waste Disposal

Well-developed water and sanitation systems are not yet available in the rural areas of the District. Rural people usually obtain fresh-water for domestic purposes from dug or tube wells. Outside the urban areas of Mangalore, Udupi and Karkala, there are no engineering systems for the collection and treatment of domestic wastewater. Some rural residents utilize latrines with septic tanks or seepage pits. Solid waste management is not practised, and most wastes are usually recycled, while the remainder may be disposed of haphazardly.

### Energy Supply

Although all villages in the District receive electricity, the demand for cooking heat creates energy deficits. Some biogas production offsets this deficit, but the continuing demand for fuelwood is more than the sustainable yield from forests and common lands.

## Potential Environmental Problems

Agricultural holdings are decreasing in size with 85% of all holdings now being less than 2 ha, and over half of these being less than 0.5 ha. Such a situation is not favourable to good land management or the environment. As the number of farm holdings increases, more wells will be bored, and more houses constructed, and the need to collect fuelwood and green leaf manure is likely to be proportionately more.

Increased demand for agricultural land, and subsequent utilization of marginal and common lands, will result in loss of biomass support areas and soil erosion. New farming practices will increase the use of fertilizers and pesticides and usually require intensive irrigation.

The increasing area of mono-cropped plantation crops especially areca-nut, coconut, and cashew is reducing the District's output of food grain and increasing the use of fertilizers, pesticides and irrigation water.

Adverse environmental impacts as a result of these activities include:

- contamination of ground and surface waters with nutrients and toxic chemicals,
- siltation of ecosystems and aquatic habitats and reduction in water clarity,
- groundwater depletion
- deforestation, and
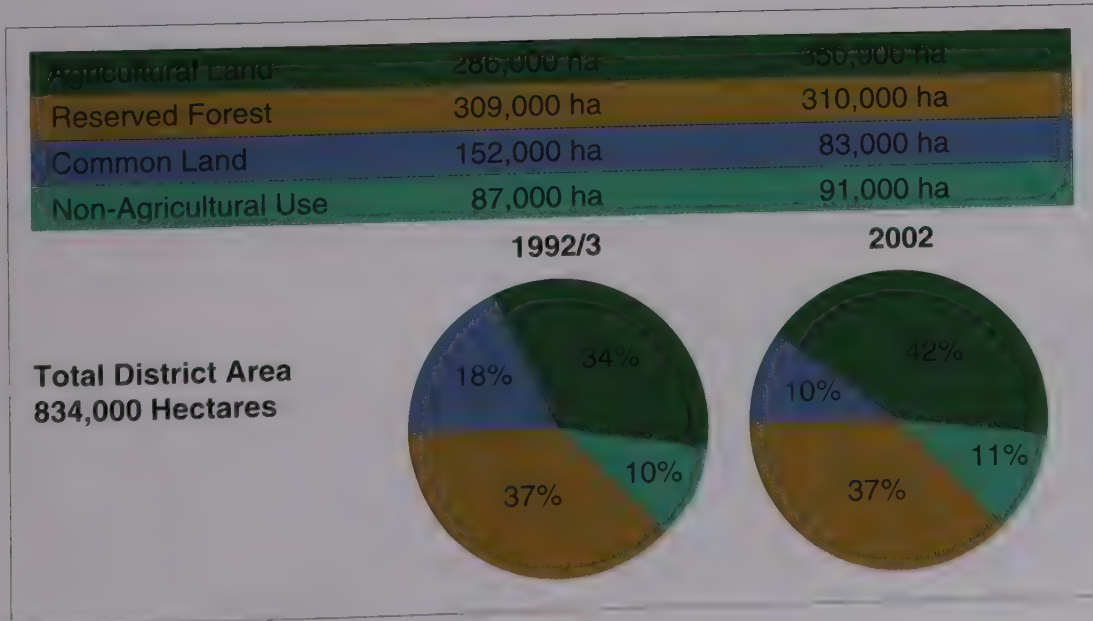- reduction of biodiversity

## Interventions

The interventions necessary to ensure that rural development will not be harmful to the natural resources and ecosystems are listed under the respective natural resources and ecosystems.



*In rural areas, there is little in the way of appropriate sanitation systems.*



*The increasing area of plantation crops are reducing the District's output of food grain and increasing use of fertilizers and pesticides.*

| | 1992/3 | 2002 |
|---|---|---|
| Agricultural Land | 286,000 ha | 350,000 ha |
| Reserved Forest | 309,000 ha | 310,000 ha |
| Common Land | 152,000 ha | 83,000 ha |
| Non-Agricultural Use | 87,000 ha | 91,000 ha |

**Total District Area
834,000 Hectares**

1992/3: 34%, 18%, 37%, 10%

2002: 42%, 10%, 37%, 11%

*Present and predicted land use.*

## Economic Conditions

### Present District Domestic Income

Overall economic development in the District can be broadly expressed by income per capita. On this basis, the District was ranked the third highest in the State in 1990/91. The district income per capita was Rs 2,392 compared to a state value of Rs 2,055. The annual growth in income per capita since 1980/81 has been higher in the District (3.5%) than in the State (3.0%) and in the Nation (3.2%).

### Sector Development

Over the last decade, district as well as state development has been characterised by a significant shift from a primary sector dominated economy to a tertiary sector driven economy.

### Primary Sector

Economic activities in the primary sector include agriculture, forestry, fishing, mining and quarrying.

Dakshina Kannada has the richest fishery resources in Karnataka. It has large forest resources, and the heavy seasonal rainfall is a valuable asset for agriculture.

Agriculture is by far the most important sub-sector in terms of income, followed by fishery. Mining and quarrying is of less importance.

### Secondary Sector

Manufacturing, construction and utilities are the economic activities in the secondary sector.

The manufacturing industries, especially small, unregistered companies, dominate the secondary sector in the District.

### Tertiary Sector

This sector comprises transport, communication, trade, hotels and restaurants, banking and insurance, real estate, ownership of dwellings, business services, public administration and other services.

Business in the tertiary sector has achieved an aggregate annual growth rate in the domestic product of around 7.5%, as compared to a corresponding 7.2% growth rate at state level. The financial sector, including banking and insurance, has achieved a remarkable annual growth rate of more than 10%, whereas the growth rate of the sub-sector, consisting of trade, hotels and restaurants, has been around 8% per year.

### Employment

The labour force amounted to 41.1% of the total population of the District in 1991 compared to 38.5% at state level. Likely reasons for the higher labour percentage in the District include lower population growth and higher female employment. The District has registered a 48.6% growth in the work force over the past 20 years, which is much greater than the rate of growth in the District's population (39%). There is also a very high rate of emigration by people in search of employment and business opportunities elsewhere.

The occupations are grouped into four broad sections including cultivators, agricultural labourers, other workers, including household industry workers, and marginal workers. The primary sector dominates employment in the District. However, there is a clear shift in the work force from the farming sector to the industrial and service sectors due to increased employment opportunities in the latter areas.

### Development Scenario

### Sector Development

Based on an estimate of growth over each of the activities within the primary sector, it may be estimated that the primary sector contribution to the Net District Domestic Product (NDDP) will grow at an annual rate of 2% up to 2002.

For the secondary sector, the trends are divided into two phases. For the initially forecasted period 1993/94-1997/98, industrial development will continue without any significant impact by large-scale industries. The annual growth rate, as measured through the sector contri-

| Year 1990-91 | DK (Rs lakhs) | DK % | State (Rs lakhs) | State % |
|---|---|---|---|---|
| Primary sectors | 20,187 | 31.2 | 323,262 | 34.9 |
| Secondary sectors | 17,721 | 27.4 | 230,430 | 24.9 |
| Tertiary sectors | 26,814 | 41.4 | 371,575 | 40.2 |
| Total income | 64,722 | 100 | 925,267 | 100 |

*Composition of State and District Domestic Income for 1990/91 by Sectors at 1980/81 Prices.*
*Source: Directorate of Economics and Statistics, Bangalore.*

bution to NDDP, is estimated at 5%, which represents a marginal increase as compared to the recorded growth rate of 4.9% during the past decade. It is estimated that the annual growth of the secondary sector will increase to 7% during the period 1997/98-2002/03.

The tertiary sector, providing services to the primary and secondary sectors, is not expected to perform at the same high growth rate as during the previous decade due to saturation within certain sub-sectors. The estimated growth rate during the period 1993/94-1997/98 is estimated at 6% and, due to increased activity in the secondary industries, the annual growth rate of the tertiary sector is forecasted at 7% during 1997/98-2002/03.

**Employment**
The labour force is broadly defined as the total number of adults within the age group 15-60 years. This labour force definition includes all females who, in reality, will not be available for the labour market. Therefore, an estimation of unemployment should focus on the development trend rather than absolute figures.

An indicator of unemployment is the total projected number of people in the labour force minus the projected number of people employed.

Employment opportunities will be created in the secondary and tertiary sectors, giving an estimated increase of a total of 70,000. The major employment opportunities will be created in the Mangalore and Udupi areas. Simultaneously, it is expected that around 45,000

| Worker Segments | 1981 | | 1991 | |
| --- | --- | --- | --- | --- |
| | Actual Figures | % of Total | Actual Figures | % of Total |
| Cultivators | 237,673 | 23.9 | 219,324 | 18.8 |
| Agricultural labourers | 184,764 | 18.6 | 178,879 | 15.4 |
| Other workers including household industry | 528,256 | 53.1 | 714,246 | 61.4 |
| Marginal workers | 43,745 | 4.4 | 50,465 | 4.3 |
| Total main workers | 994,438 | | 1,162,914 | |

*Distribution of Total Labour Force in the District, 1981 and 1991.*
*Source: District Census Handbook 1981. 1991 District Census abstract compiled by National Informatics Centre, Bangalore.*

agricultural labourers and cultivators will leave agriculture. In all, the net employment created over the next decade is estimated at 25,000. However, since the available work force is expected to grow as population increases, employment problems will increase.

**Economic Instruments for Sustainability**

More specific economic policy measures need to be employed to mitigate negative effects or enhance positive effects of existing policies on preservation of natural resources and ecosystems.

**Intervention**
The following intervention is proposed in order to identify and implement the necessary instruments.

I 3:  Introduction of Economic Instruments in Conserving Natural Resources and Ecosystems.

| | 1992/93 | 1997/98 | 2002/03 |
| --- | --- | --- | --- |
| Primary sectors | 475 | 452 | 430 |
| Secondary sectors | 365 | 384 | 414 |
| Tertiary sectors | 275 | 282 | 296 |
| All sectors | 1,115 | 1,118 | 1,140 |

*Present and Projected Employment (in thousands).*
*Source: District Primary Census Abstact, 1991.*

# District Development

## Social Conditions

### Present Population and Growth Patterns

The District's 2.69 million people represent 6% of the state population.

The District has experienced a decreasing population growth rate which remains lower (1.26% during the period 1981 to 1991) than the all-India average of 2.0% during 1981 to 1991. There are 26 settlements in the District that are classified as urban. Many of these urban areas have grown by over 100% from 1971 to 1991. The growth rate in rural areas is decreasing.

### Health

The District compares favourably with national and state averages in basic indicators of health status. The indicators include declining mortality and infant mortality rates, higher life expectancy at birth for both males and females, a relatively low proportion of malnourished children below the age of five, and improved healthcare facilities.

### Education

Dakshina Kannada has shown considerable achievement in education and has been called a "Totally Literate District" in the year 1992. The social environment encourages education, which is borne out of the fact that school enrolment from all segments of society, including Scheduled Castes and Tribes and minority groups, is high compared to other districts in the State.

### Occupational Health

Many of the jobs in the District are considered hazardous. Of the 19 different categories of industries in the District, 12 have been identified as involving hazardous processes. The hazards are chemical, physical or biological in form; mechanical risks involving machinery or tools; and physical and mental strain from heavy, monotonous, intense or prolonged work.

### Women

Women play a significant role in the socio-economic development of the District. Indicators include the high female literacy rate, high female participation in the work force, high female contribution to, and responsibility for, household economy and industrial dependency on female labour participation (i.e. tiles, cashew, areca-nut, fish processing units, and beedi-rolling). Several women's organizations have emerged in the District. Women have a crucial role not only in contributing to the household economy, but also in interacting with the natural resource base by tending cattle, collecting fuelwood and fodder, disposing of domestic waste and tending fruit-bearing and other trees.

### Weaker Sections in Development

Scheduled Castes (SCs) and Scheduled Tribes (STs) comprise 6.5% and 3.9% of the district population. The special welfare programmes provided for these groups by the Government and NGOs have been instrumental in improving social and economic conditions.

### Development Scenario

A positive development related to the general welfare of the District is expected. During the period 1990/91 to 2002/03, the per capita income in the District is projected to increase by 50%. The Human Development Index (HDI) which was 0.59 in 1990/91 (national average 0.34) will further increase to 0.67. Infant mortality rate (IMR), a key indicator of human well-being, is expected to improve from the 1990/91 figure of 32 deaths per thousand live births to 20 per thousand in 2002/03. This is comparable to the norm of 5-10 deaths per thousand live births in developed countries. When making future predictions, it is assumed



*Dakshina Kannada has been declared a 100% literate District.*

that the Government will continue efforts to incorporate considerations of equity in development through various social welfare schemes.

## Areas of Concern

The quality of the industrial working environment in the District varies considerably, and only a few of the larger industries have any type of formal health and safety programmes for employees. It is expected that most of the new industries coming to the District will be classified as hazardous and dangerous with regard to occupational health and safety concerns. If health and safety issues are not given greater consideration, then more workers will be placed at risk.

As common lands decrease or are degraded, poor and landless persons will have to spend more time and energy in search of diminishing supplies of fuel, fodder and other land-based resources to maintain their livelihood.

Scheduled Castes and Scheduled Tribes, who have customarily depended on forest resources and traditional agricultural practices for their livelihood, will be adversely affected by diminishing forests and common lands, and the change of cropping patterns from food crops to cash crops and plantation.

Losing the opportunity to work as agricultural labourers and to sustain themselves on the land, many may migrate to urban areas in search of alternative employment.



*Beedi-rolling has become an important employment for women in the rural areas.*

## Public Awareness and Participation

Public awareness of environmental issues is fairly high compared to other districts. Evidence of this awareness is seen in people's effort to conserve the Western Ghats. However, interest in environmental issues in the District has primarily been confined to environmental activists and a few NGOs. Efforts to involve wider sections of the population have not yielded substantial results and the general movement regarding environmental issues has been project and problem-specific rather than a broad approach involving environmental education, protection and conservation.

There are 29 NGOs in the District which are involved in activities such as women and child welfare, poor and weak social sections and education.

### Intervention
To create more awareness among the general public of the importance of protecting the environment, and to promote more public participation in the decision-making process for natural resources utilization and conservation, an intervention is proposed;

I 16: Plan for Increasing Public Awareness and Participation in Environmental Issues.

# Agricultural Land

### Present Quantity and Quality

Approximately 286,000 ha, or 34% of the District area, consists of agricultural land. This figure includes the official figure for net area sown, plus existing fallow lands, and an estimated 49,000 ha of common land which have been encroached on and cultivated.

Rice and pulses are the District's principal food crops and occupy about 55% of the net area sown. By 2002, it is estimated that there will be a requirement for 350,000 ha of agricultural land, whereas the supply of moderately good agricultural land, as estimated by the National Bureau of Soil Survey and Land Use Planning, will remain steady at about 286,000 ha.

Almost all the agricultural land in the District is limited by at least one undesirable factor such as erosion susceptibility, shallow soil depth or low water holding capacity. These deficiencies, along with declining levels of nutrients and organic material, result in a low agricultural productivity. The sustainability of organic nutrient inputs is being threatened since traditional sources of green manure, such as common lands, are either being cultivated, degraded or encroached on.

### Cropping Patterns

Where irrigation is utilized, the predominant pattern in the District is to grow at least two crops of rice. Under this practice, available phosphorus and potash are diminished. Growing pulse, groundnut or vegetables after a single rice crop appears to improve soil fertility and prevent the build-up of pests and disease. A plantation crop with good ground cover is generally more suitable for environmental conditions in the District because it provides permanent cover and protects fragile soils during intense monsoon rains. The large farm holders mostly intermix field crops with plantation crops to manage soil fertility and erosion.

### Soil Management

The topography and seasonally intense rainfall of the District are factors which increase the potential for soil erosion. The Western Ghats and the midland zones are the most vulnerable if the natural forest and vegetation are disturbed or if agricultural lands are not properly planned and managed. The coastal zone is moderately level and fields are protected by bunds covered by vegetation. However, even under these relatively ideal conditions, during one monsoon season, soil erosion was measured at 5.3 tonnes per ha. It is foreseen that erosion will increase as net area sown extends to more unsuitable lands such as the foothills of the Ghats, and if farmers ignore soil conservation measures.

### Irrigation

It is projected that farming will become more dependent on irrigation as more areca-nut, coconut and high-yielding varieties of field
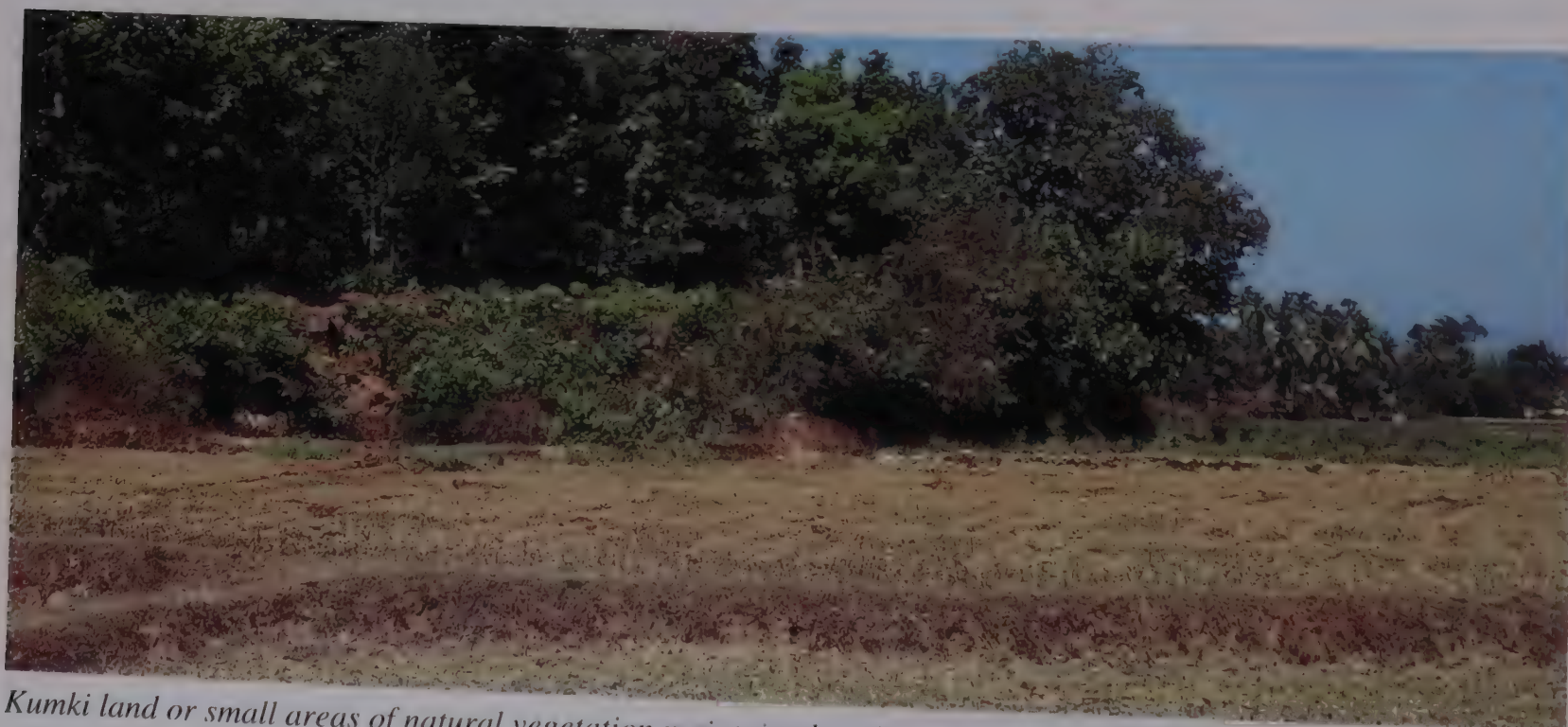


*Kumki land or small areas of natural vegetation maintained on farms to supply plant biomass, is often replaced with crops, and common land serving the same purpose is degraded .*

crops are grown. The expansion of net area sown will put more pressure on ground water than on surface water as agricultural land spreads inland away from streams. Intense competition for ground water resources may result in lowered water tables and subsequent water shortages during the dry season.

## Major Problem Areas

Major agricultural land problems include exploitation of land without due consideration to land capabilities and the use of marginal lands for cultivation. Biomass producing support areas, which are important for maintaining soil fertility, are declining in the coastal and mid-land zones. Other problems include research on high crop yields without examining long-term consequences on overall productivity, reduction of agricultural biodiversity through the introduction of high yielding varieties, and the use of highly toxic pesticides. By 2002, it is estimated that 97% of farm holdings will be small or marginal.



*Soil erosion is one of the greatest environmental problems in Dakshina Kannada District.*

## Long-Term Objectives

To ensure sustainable development of agricultural land the following long-term objectives and the following interventions, which will ensure achievement of these objectives, are proposed.
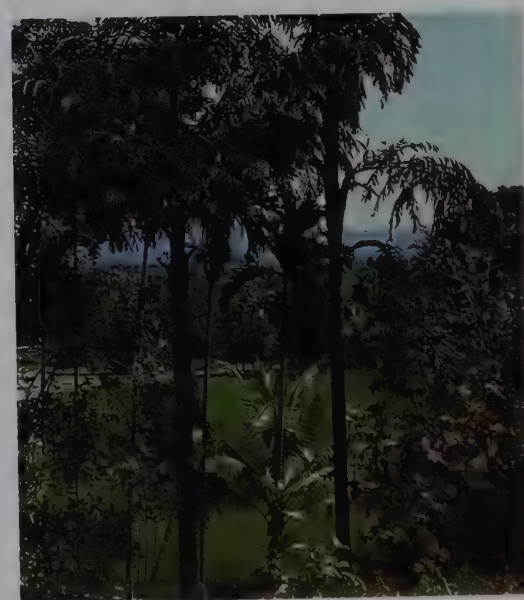
"Agricultural land is used sustainably for the production of food and other useful products so that this resource is safeguarded for the future."

## Indicators

- Productivity of land on small and marginal holdings using 3-year average trends for all taluks.
- The amount of soil erosion from agricultural land monitored by measured sediment load in key rivers during the south-west monsoon.
- Widespread use by farmers of agricultural technologies and management practices which conserve agricultural land and ecosystems.
- Use of highly toxic broad spectrum pesticides.
- The level of application of commercial fertilizers per unit area of land.

## Interventions

I 1: Water Resources Monitoring and Management
I 4: District Land Use Plan
I 14: Plan for Participatory Management of Common Lands and Forests
I 15: Strategies for Improved Agricultural Practices
I 17: Promoting Environmental Aspects in Agricultural Research
I 18: Conservation and Management of Agricultural Biodiversity.



*Promotion of appropriate crops or cropping patterns based on land capability is one of the interventions suggested by the EMPS.*



*Analysis of typical soils in the Ghat zone indicate a correlation between different levels of soil fertility and different amounts of natural vegetation.*

## Forests and Common Lands

### Present Quantity and Quality - Forest Lands

The area of forest is estimated as 309,000 ha, or 37% of the District's area. A sufficient quantity of forest is needed to protect erosion-prone areas, regulate flooding, promote ground water recharge, and maintain biodiversity. To fulfil these important functions, the National Forest Policy (1988) recommends that 431,000 ha, or 52% of the District's area, be under forest cover. Thus, there is a discrepancy between the quantity of forest recommended to maintain a good environment and the existing forest cover. The forest deficit will probably not be lessened in the future as it is predicted that the quantity of forest will only marginally increase.

Forests are used as a source for timber, fuelwood, leaf manure, medicinal plants, and non-wood forest products (NWFP).
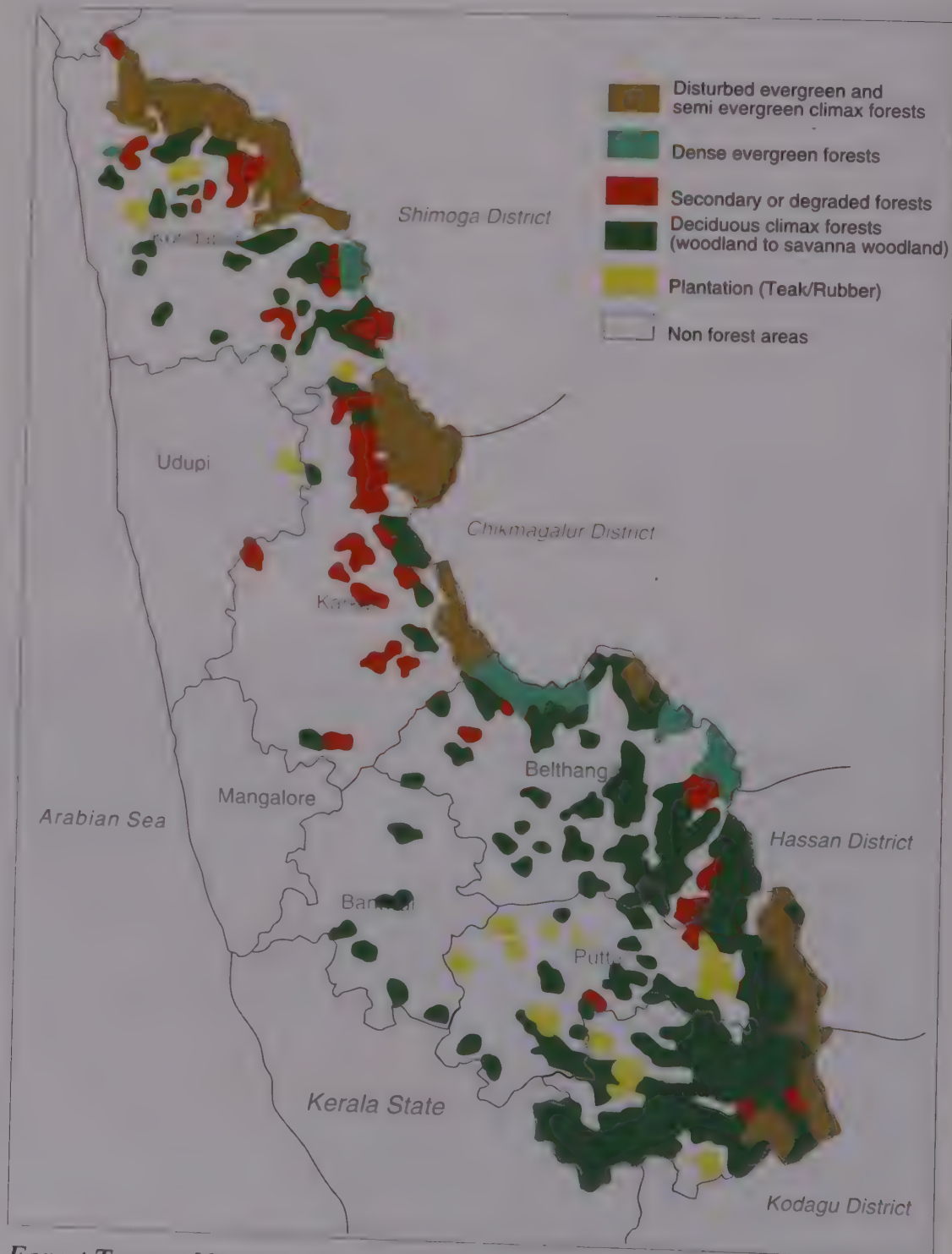
The ban on green felling in 1987 has stopped the over-exploitation of timber which had previously taken place. But many parts of the forest are still degraded due to human activities. Weeds have become dominant in many areas and good tree growth is confined to valleys and depressions. The trend is that the quality of accessible forests is declining.

### Major Problem Areas

The extraction of NWFP, if managed wisely using the participation of local people, could provide a mechanism for the protection and conservation of the forests. However, the current system of offering time-bound leases for their exploitation —

which does not promote sustainable harvest — has resulted in the over-exploitation of forest resources.

Due to a lack of inventories of forest resources and their rates of growth or reproduction, it is difficult to formulate adequate management plans for the sustainable use of the forests.



Legend:
- Disturbed evergreen and semi evergreen climax forests
- Dense evergreen forests
- Secondary or degraded forests
- Deciduous climax forests (woodland to savanna woodland)
- Plantation (Teak/Rubber)
- Non forest areas

Map labels: Shimoga District, Udupi, Chikmagalur District, Kar..., Belthang..., Mangalore, Arabian Sea, Hassan District, Ban..., Putt..., Kerala State, Kodagu District

*Forest Types of Dakshina Kannada. Based on forest map of South India published by the Karnataka Forest Department and the French Institute, Pondichery.*

## Present Quantity and Quality - Common Lands

Natural vegetation on common lands supplies the biomass that farmers need to maintain soil fertility. It is currently estimated that about 152,000 ha, or 18% of the District's area, are being used for this purpose. However, calculations, which predict how much biomass is required to sustain fertility of agricultural soils, indicate that 219,000 ha (26% of the District's area) is required to produce the needed agricultural inputs. By 2002, it is estimated that cropping patterns will require a common land support area of about 281,000 ha. The future amount of common land is expected to dwindle to 83,000 ha, indicating that the deficit between required and available commons lands will greatly increase.

The quality of common land is usually measured in terms of biomass production. In the District, common lands are generally low in quality due to over-extraction of fuelwood, exploitation of timber and uncontrolled grazing of cattle. With the conversion of Kumki land to plantation crops, other less supportive lands and accessible reserved forests will have to be found to supply the biomass needed for agriculture. As available common lands decline, extra pressure will be placed on what remains and hence the quality of the land will be threatened.

## Major Problem Areas

In the absence of any management plan, common lands are declining in both area and quality. The value of these lands, in terms of natural biomass production, is estimated to be more than Rs 3,400 per ha per year. Nevertheless, the value of common lands is generally not appreciated and their rate of disappearance is alarming.

## Long-term Objectives

To ensure sustainable development of forests and common lands, the following long-term objectives and the following interventions, which will ensure the achievement of these objectives, are proposed:

"Adequate forests and common land exist to meet the biomass demand."

## Indicators

- The availability of green manure as measured by the ratio of biomass-producing support area to area sown.
- The amount of soil erosion from forest lands, monitored by measuring sediment load of key rivers during the south-west monsoon.

- Effective forest area or the geographical area of different types of forest land multiplied by its average crown density.

## Interventions

I 4:  District Land Use Plan
I 11: Environmental Management Plan for Energy
I 14: Plan for Participatory Management of Common Lands and Forests.

**Common Lands.**
Refer to the lands loosely controlled by the Revenue Department since last century. They are used in common by villagers and different local names apply to them. Traditional management systems which may have once been practiced have usually broken down so that common lands are used as an open access resource and are thus often degraded.



*Population pressure is one of the threats to forests and common lands.*

## Western Ghats

### Present Situation

The total extent of the Western Ghats in the District is estimated at around 46,100 ha. The evergreen forests in the District are some of the most diverse and unique types found in any district forming the Western Ghats. Most of the lowland evergreen forests in Kerala, Goa and Maharastra were cleared long ago.

### Flora and Fauna

The Western Ghats area of the District contains a wide variety of flora and fauna which contribute to the high biodiversity of the region. A few species are exclusively endemic to the District. There are over 480 species of plants that are considered medicinal, and more than 180 edible plant species.

Since this area is dominated by vegetation, the Western Ghats do not support a large diversity of mammals. Except for the wild pig, the density of major mammal species is low. The low natural prey base has resulted in small numbers of carnivores such as tiger and leopard. Other large mammals include the Indian gaur, sambar, chital, lion-tailed macaque and the Malabar civet. About 250, or half the estimated existing population of the lion-tailed macaque, an endangered species native to the Indian peninsula, are living in Dakshina Kannada. The Malabar civet is another endangered animal which has been sighted in many locations throughout the Western Ghats area in the District.

### Threats to the Western Ghats

Loss of natural habitat and subsequent decline in biodiversity are major issues of concern, especially considering the rare and endangered species that are found in the forest sections of the District. Habitat areas in the lowland evergreen forests are being damaged due to encroachment and improper management of forest resources.

Iron ore mining activities in the vicinity of Kudremukh National Park are also threatening the biodiversity of the area. Dispersal of mine tailings into local streams is potentially harmful to fish and aquatic ecosystems. Other activities which could be harmful to the Western Ghats include timber harvesting, uncontrolled collection of NWFP, farming and plantations, cattle grazing, and poaching.
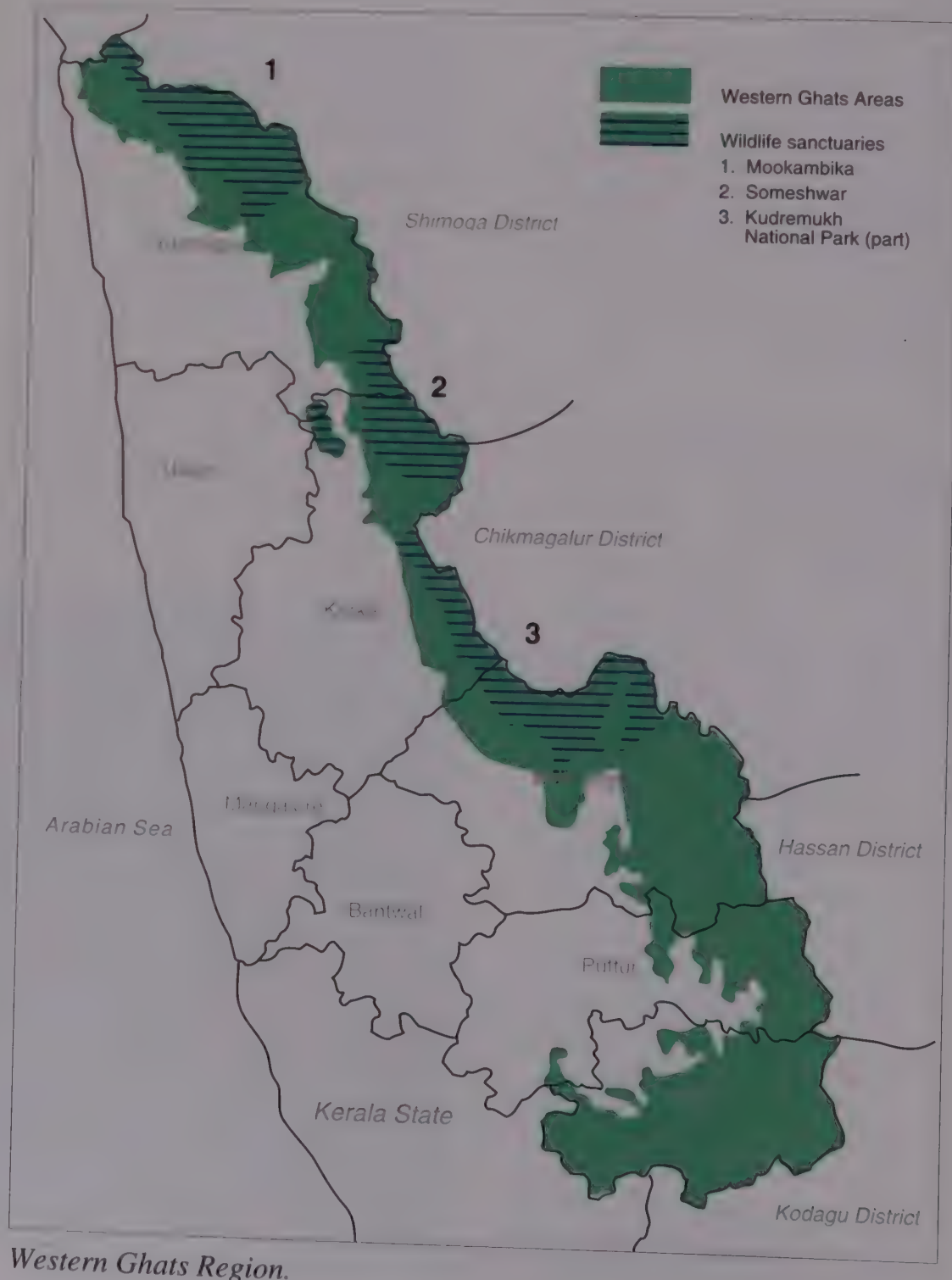


Western Ghats Region.

## Long-Term Objectives

To ensure sustainable development of the Western Ghats, the following long-term objectives and the following interventions, which will ensure the achievement of these objectives, are proposed.

"Diversified and well-functioning ecosystems throughout the Western Ghats region."

### Indicators

- Presence of endemic species of fauna and flora.
- Protected areas networked.
- Extent of area of ecosystems.

### Interventions

**I 2:** Air Pollution Monitoring and Modelling

**I 4:** District Land Use Plan

**I 7:** Biodiversity Conservation and Management

**I 14:** Plan for Participatory Management of Common Lands and Forests.



*The Lion-tailed macaque is a highly endangered species of monkey found only in the Western Ghats of Karnataka, Kerala and Tamil Nadu.*



*An example of a unique and beautiful scenery.*

# Ground Water

### Present Quality and Replenishment

Ground water assessments for the District are undertaken by the Department of Mines and Geology and the Central Ground Water Board (CGWB). Annual ground water replenishment is estimated i.a. by monitoring ground water level fluctuations in key monitoring wells.

The Central Ground Water Board also collects water samples from observation wells for analysis of physical and chemical parameters. No major chemical quality problems have yet been observed. However, some wells near the coast are seasonally affected by salt water intrusion and high nitrate content.

Microbiological parameters are not routinely monitored, but limited testing has found bacteria levels in excess of permissible hygienic limits in shallow wells.

A special EMPS Baseline Study on River Flow and Ground Water Replenishment has been designed to build tools and methodologies for estimating ground water resources available in specific areas. In another EMPS effort, a water quality baseline and monitoring programme was established for ground water. The baseline study focuses on areas likely to be under threat from various sources of pollution, including the Mangalore urban area, where quality data are not readily available.

### Present and Projected Abstraction

At present, only the ground water withdrawn to supply part of the domestic and industrial needs for the Mangalore area is recorded accurately. Other uses of ground water have to be estimated using assumed unit application rates for irrigation, livestock maintenance and domestic purposes.

By comparing total ground water consumption to annual replenishment for each taluk, it can be concluded on an overall basis that no taluk is using more ground water than is naturally replenished. However, activities in Mangalore, Sullia and Bantwal taluks are placing most pressure on ground water resources, a situation which may cause supply deficits at some locations within these areas.

In the future, ground water consumption could increase significantly due to: increased area under cultivation; expansion of industrial activities; increased population;



*Annual replenishment distributed on taluks (mcm).*
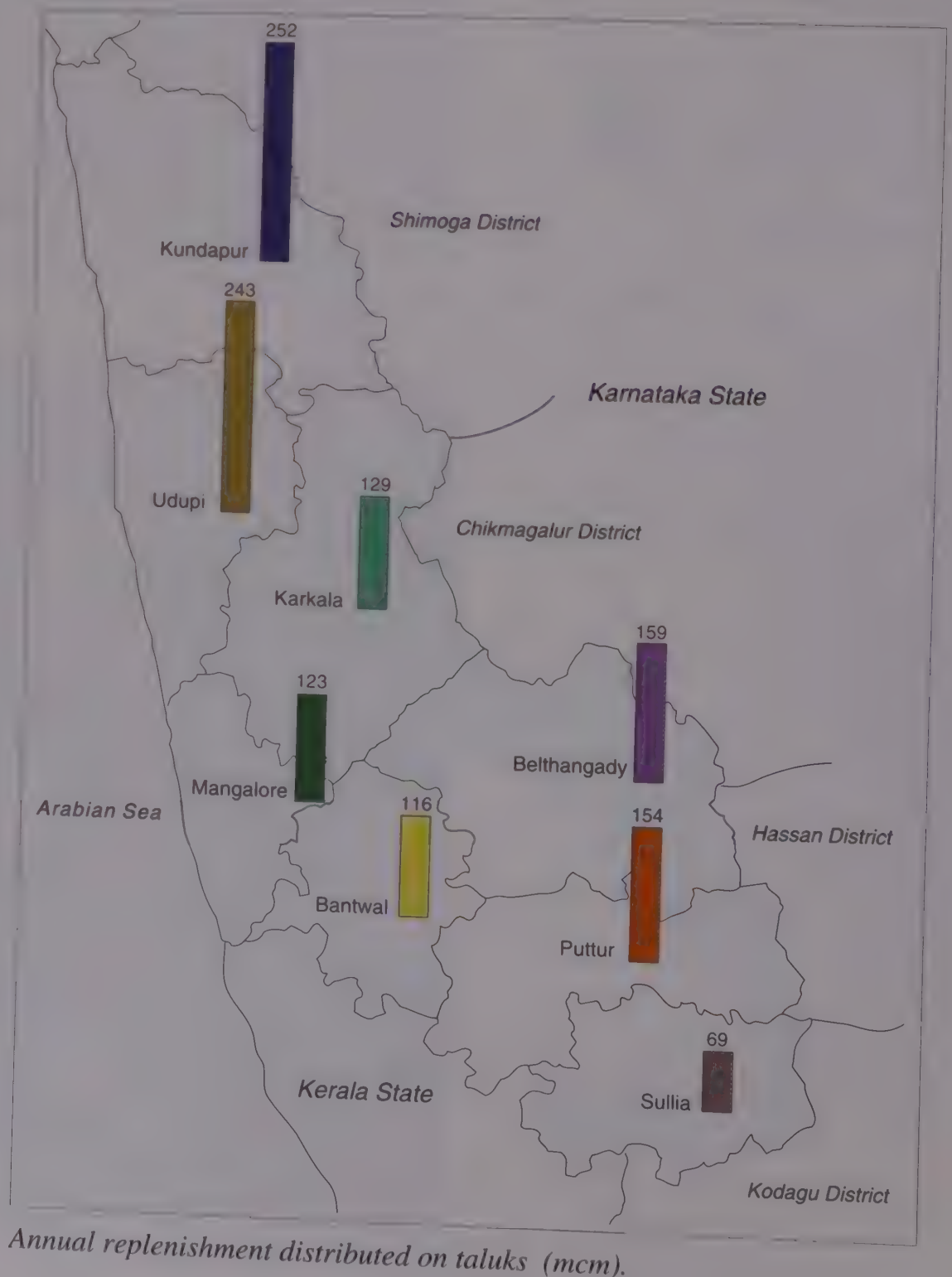
*Use of ground water is expected to increase significantly and over-exploitation of this resource will lead to dry-up of many wells during the dry season.*

leakage from underground sewer and drainage systems.
• Seasonal over-exploitation leading to salt water intrusion in some coastal locations.
• Contamination from over-application of pesticides and fertilizers.

## Long-Term Objective

To ensure sustainable development of ground water resources, the following long-term objectives and the following interventions, which will ensure the achievement of these objectives, are proposed.

> "No net depletion of ground water reservoirs, and the water quality should comply with current national standards of drinking water."

and increased unit consumption as living standards improve. By 2002, ground water consumption in the District could double.

## Major Problem Areas

Certain components of district development are likely to threaten ground water resources in the

future. To some extent, these problems are already occurring, but there are insufficient data to thoroughly analyze the severity of the impact.

The problems include:
• Contamination by uncontrolled leachate from industrial and domestic waste disposal sites and

## Indicators

• Maximum level of ground water table at the observation wells.
• Minimum level of ground water table at the observation wells.
• Water quality parameters in relation to the current national standards.
• Total exploitable resource and percentage presently used.

| Taluk | Urban/rural Domestic & Others Consumption | Irrigation | Total Estimated Consumption | Annual Replenishment | Consumption vs. Replenishment |
|---|---|---|---|---|---|
| | (mcm/year) | (mcm/year) | (mcm/year) | (mcm/year) | % |
| Bantwal | 5.6 | 67 | 73 | 116 | 62 |
| Belthangady | 3.8 | 58 | 62 | 159 | 39 |
| Kundapur | 5.7 | 39 | 45 | 252 | 18 |
| Karkala | 5.2 | 50 | 55 | 129 | 43 |
| Mangalore | 4.5 | 63 | 67 | 123 | 55 |
| Puttut | 4.2 | 45 | 49 | 154 | 32 |
| Sullia | 2.1 | 38 | 40 | 69 | 58 |
| Udupi | 12.6 | 67 | 80 | 243 | 33 |
| Total District | 43.7 | 427 | 471 | 1,245 | 38 |

## Interventions

I 1: Water Resources Monitoring and Management
I 8: Solid Waste Management
I 9: Upgrading of Urban Sewerage and Drinking Water System
I 10: Environmental Impact Assessment Guidelines for Industries and Development Projects
I 13: Pollution Control Monitoring and Management.

*Preliminary estimates for the current annual consumption of ground water.*

# Surface Water

### Present Quantity

The District is drained by an extensive network of west-flowing rivers with outlets to the Arabian Sea through estuaries. In some cases, 2-3 rivers converge into one estuary.

A total of 13 river gauging stations are operated at 6 rivers by the Central Water Commission (CWC) and the Water Resource Development Organisation (WRDO). The estimated average annual flow of the District's rivers is given in the Table on the next page; approximately 80% of the average rainfall flows to the sea.

The rivers are mostly rain-fed with magnitude of river flow closely related to seasonal rainfall. During the monsoonal period, the rivers frequently overflow; and for the dry months of December to May, the rivers often experience periods of no-flow.

### Present Quality

Few data are available on water quality for the major rivers in the District. The CWC regularly collects and analyzes samples from three of the gauging stations in the District. No conclusions can be drawn from these data, but information will be available in the future as part of ongoing baseline studies. However, it is apparent that some rivers suffer from pollution problems.

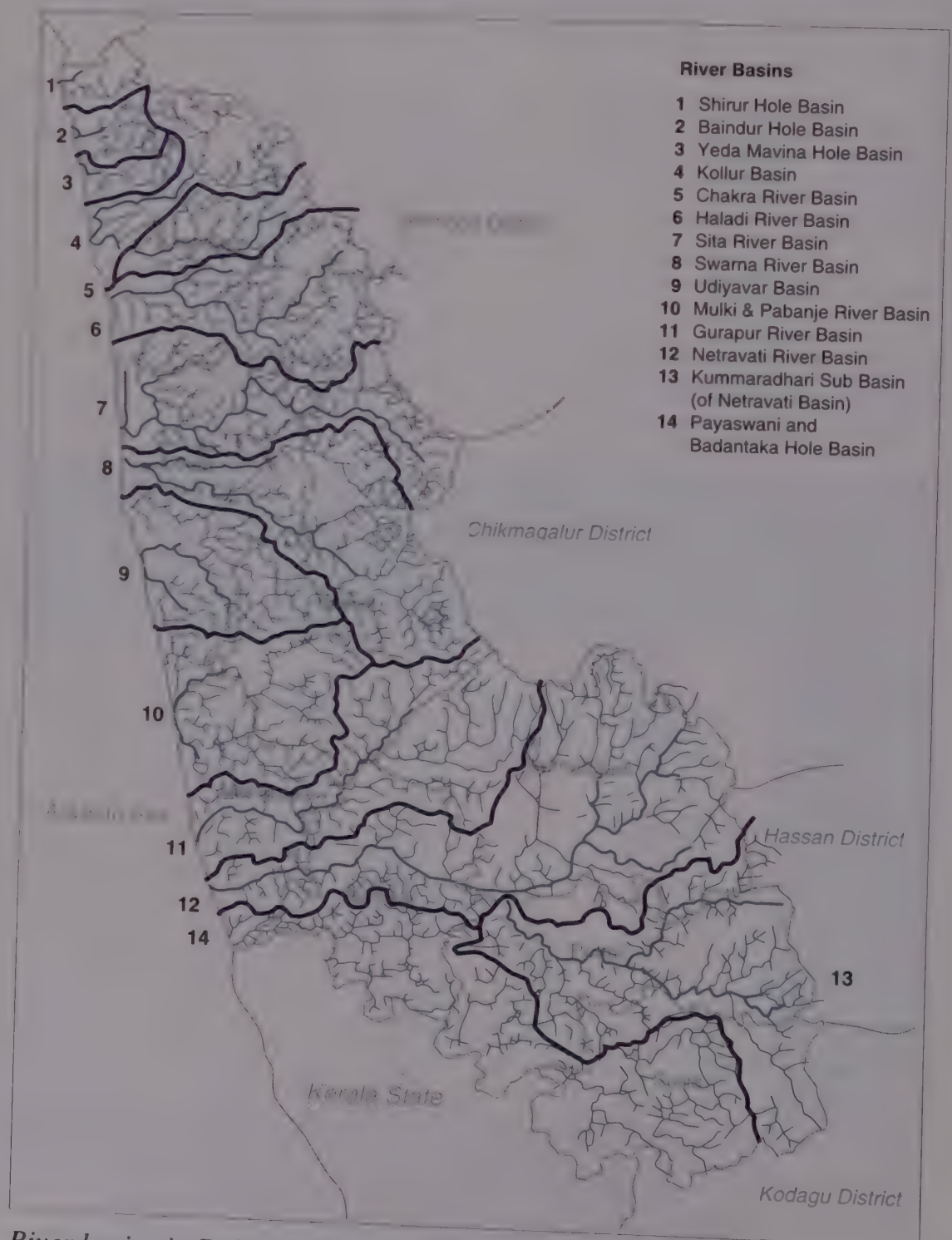### Present and Projected Utilization

At present, river water use is measured only at the intakes for water supply to Mangalore and Udupi urban areas. Similar to ground water extraction, estimates for the remaining water use are based on assumed unit application rates for irrigation, livestock maintenance and domestic purposes.

The total surface water consumption is estimated at 759 mcm/year (about 60% of the total consumption) of which irrigation accounts for some 95%. The present total consumption only amounts to about 2.5% of the total river flow.

Demands on surface water in the District are likely to increase because of the following reasons:

• Large-scale industries planned for the Mangalore area and the expansion of existing industries;
• Increased agricultural area under cultivation; and
• Increased population compounded by an increase in unit water utilization.



**River Basins**

1. Shirur Hole Basin
2. Baindur Hole Basin
3. Yeda Mavina Hole Basin
4. Kollur Basin
5. Chakra River Basin
6. Haladi River Basin
7. Sita River Basin
8. Swarna River Basin
9. Udiyavar Basin
10. Mulki & Pabanje River Basin
11. Gurapur River Basin
12. Netravati River Basin
13. Kummaradhari Sub Basin (of Netravati Basin)
14. Payaswani and Badantaka Hole Basin

*River basins in Dakshina Kannada.*

It is estimated that the surface water requirement by year 2002 may grow by more than 40 million mcm/year, an increase of about 6% on a district-wide basis. Even though this growth appears relatively modest, it will increase the current problems of surface water shortages, if not managed appropriately.

## Major Problem Areas

Pollution sources that could threaten the future quality of river water in the District include:

- Nitrate compounds drained and leached from agricultural and common land;
- Leachate and run-off from unmanaged industrial and domestic waste piles;
- Pesticide residues from agricultural land and forests;
- Oxygen-consuming organic material, bacteria and pathogenic organisms directly discharged from domestic sewage treatment facilities and from temples and pilgrimage locations; and
- Oil and grease, solids and a variety of pollutants from urban area drainage systems.

Water quality problems will probably be compounded by a lack of available river water during the dry months when surface supplies are over-exploited and saline waters ingress upstream and threaten freshwater resources.

## Long-Term Objectives

To ensure sustainable development of surface water resources, the following long-term objectives and the following interventions, which will ensure the achievement of these objectives, are proposed.

"Surface water is available in adequate quantities and the quality should comply with the current national standards. The extraction or diversion of surface water should not have any significant environmental impact."

## Indicators

- Water availability in the form of river yield at selected locations in the 8 major rivers during different seasons.
- Water quality parameters in relation to the current national standards for various uses (as mentioned at selected locations and during different seasons).

## Interventions

I 1: Water Resources Monitoring and Management
I 9: Upgrading of Urban Sewerage and Drinking Water System

I 10: Environmental Impact Assessment Guidelines for Industries and Development Projects
I 13: Pollution Control Monitoring and Management.



*Most of the drinking water for Mangalore city is taken from Netravathi river near Thumbe and purified in a water treatment plant.*

| River Basin | Catchment Area | Basin Rainfall, Ann. Average | | River Flow Ann.Average |
|---|---|---|---|---|
| | sq.km | mm/year | mcm/year | mcm/year |
| Netravathi | 3357 | 4306 | 15747 | 12434 |
| Gurpur | 860 | 4235 | 3642 | 2915 |
| Pavanje | 205 | 3812 | 781 | 619 |
| Mulki | 338 | 4545 | 1536 | 1253 |
| Swarna | 516 | 4513 | 2330 | 1889 |
| Sitana | 670 | 4923 | 3298 | 2738 |
| Varahi | 512 | 4820 | 2468 | 2051 |
| Charkra | 272 | 4660 | 1268 | 1061 |
| Other Basins | 1296 | 4420 | 5728 | 4601 |
| Total District | 8326 | 4420 | 36797 | 29561 |

*Estimated Annual Flow of Rivers in Dakshina Kannada (EMPS, 1994)*
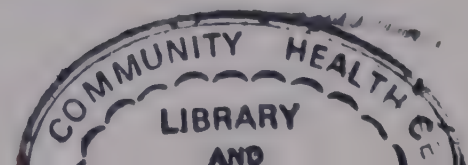
## Coastal Waters

### Present State of Coastal Waters

In general, water temperatures vary between 25 and 30°C and salinity between 3.0 and 3.5%. Existing information and data on quality aspects of the coastal waters of Dakshina Kannada, however, are scarce and scattered. Only for a few locations, do limited data exist covering a longer period. On the one hand, the existing data indicate that the levels of nutrients, e.g. nitrogen (N) and phosphorous (P), are low and, on the other hand, that algae blooms and oxygen depletion are regularly reported.

Algae blooms caused by blue-green algae are reported regularly. During these blooms, oxygen depletion problems have been observed in the bottom water. During monsoon periods, oxygen depletion problems have also been reported.

The first algae bloom, caused by a red algae, was recorded in September 1989. During this bloom, fishermen reported massive fish kill 2 km south of Mangalore. The affected species were mostly benthic fish, whereas pelagic fish, such as sardines and mackerel, were not killed. The red algae blooms have been recorded regularly since 1989, but fish kills have not been reported.

It has not yet been established to which degree the reported algae blooms and oxygen depletion problems near Mangalore are caused by outlet of nutrients from urban, industrial and agricultural activities and to which degree it is due to phenomena from nature itself. Such observations should, however, always result in further investigations.

Through the College of Fisheries, Mangalore, the EMPS project has in 1994 initiated a monitoring programme on quality aspects of the coastal waters of Dakshina Kannada. Only over time can results from such a programme be used for drawing meaningful conclusions.

### Present Pollution Load

The major pollution sources affecting the marine environment include a large iron ore company, fish processing industries, ship breaking activities and the New Mangalore Port. In terms of quantity, the iron ore company discharges the largest amount of wastewater (1.6 mcm/year) via an ocean outfall just south of the New Mangalore Port. The major contaminants in this effluent are suspended solids and heavy metals in low concentrations. In this same area, ship breaking is thought to have contributed to marine pollution. Ship movement in the area of the New Mangalore Port is likely to contribute to oil pollution. At several locations along the coast, fish processing units discharge wastes which are mostly organic with limited impact on the environment.

Within a few years, a large-scale oil refinery is scheduled to begin operation in the Mangalore area. This industry, along with several other new industries, will discharge wastewater via marine outfalls to the north of the Port, in the vicinity of Chitrapur village. The volume of industrial wastewater discharged to the ocean is likely to increase by a factor of four within the next decade. Because of the expected increase in pollution loading to the marine environment, a comprehensive monitoring programme for the
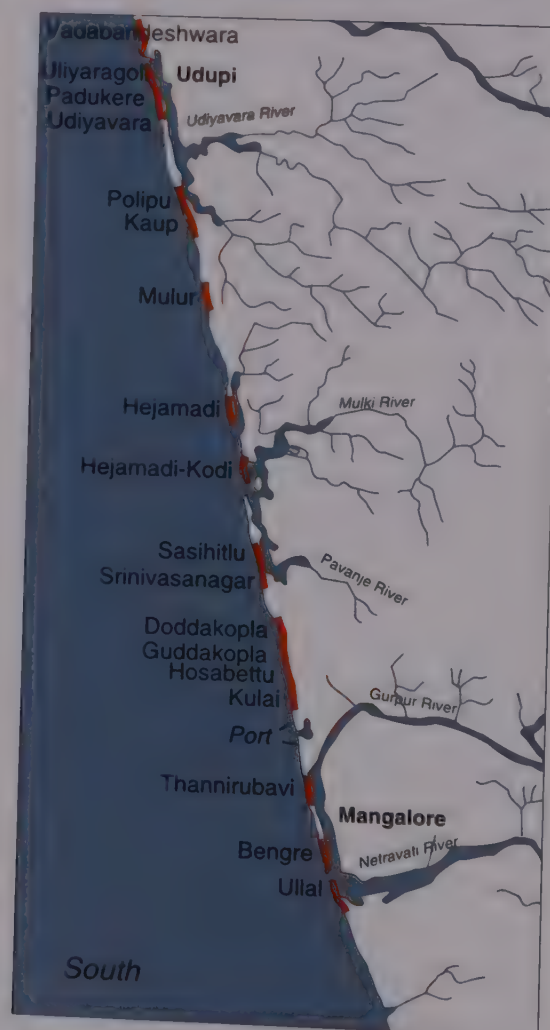


*Erosion-prone areas.*

coastal waters of the District is urgently needed, particularly in the Mangalore area. The programme should monitor long-term (chronic) as well as short-term (acute) effects of the entire range of parameters, from different species of marine life to benthic flora and fauna.

## Long-Term Objectives

To ensure sustainable development of coastal water resources, the following long-term objectives and the following interventions, which will ensure the achievement of these objectives, are proposed.

"Diversified and well-functioning ecosystems and minimal loss of land due to erosion."

## Indicators

- Oxygen saturation percentage (bottom and surface).
- Nutrients (Total-N, $NO_3$, $NH_4$, Total-P, $PO_4$).
- Algae bloom (frequency, biomass, species composition).
- "Toxicity index".
- Biodiversity index.
- Dinoflagellates.

## Interventions

I 6:  Fish Resources Monitoring and Management
I 7:  Biodiversity Conservation and Management
I 9:  Upgrading of Urban Sewerage and Drinking Water System
I 10:  Environmental Impact Assessment Guidelines for Industries and Development Projects
I 13:  Pollution Control Monitoring and Mangement.

## Coastal Erosion

Coastal erosion is a major problem along the District's narrow and sandy coastline. Erosion is caused by both natural forces and by human activities. Direct wave action onto open beaches during the south-west monsoon period causes considerable erosion, but the coastline is normally fully restored after the monsoon, and a state of dynamic equilibrium exists; the active zone can be up to 100 meter wide.

The situation is worse at river mouths and beaches adjacent to shore parallel rivers often formed as long, narrow sand spits. Here a wide active zone cannot be accepted as road and other communication lines to settlements may be cut off. Navigation channels for fishing vessels also need to be kept open.

The development activities which contribute to erosion and changes in the coastline include erection of large infrastructures and sand mining at the coast.

As construction and maintenance of hard protection measures (sea walls, etc.) are very costly, the best option will most often be a retreat from the erosion active zone. This policy was adopted in the Coastal Regulation Zone Act of 1991 in which severe restrictions are put on activities within 500 meters of the high tide mark. Efforts to establish protection measures should be focused on the locations of the most important infrastructure where the potential damage to society is highest.

The suggested long-term objective is:

"The coastal zone is managed towards minimizing losses due to erosion."

### Interventions

I 4:  District Land Use Plan
I 5:  Coastal Zone Monitoring and Management.



*Along the 135 km coastline of Dakshina Kannada District several locations are prone to erosion.*

## Estuaries and Mangroves

### Present State

Estuaries form the transition zone between freshwater and marine habitats and are highly productive in biological terms, providing an ideal site for breeding of fish, oysters, crabs, shrimps and other products of commercial value. The most productive part of the estuarine system is the intertidal and adjacent shallow water zone, which also tends to be most vulnerable to encroachment and development activities.

The most important estuaries in the District include the Netravathi and Gurpur Estuary, Mulki and Pavanje Estuary, Udyavar and Pangala Hole Complex, the Swarna-Sita-Kodi Hole Complex, the Chakra-Haladi-Kollur Complex and the Baindur Hole-Shirur Hole Complex. See map on page 30.

Mangroves are usually found in tropical environments and are typically confined to coastal areas. In addition to supporting unique vegetation types, mangrove areas and fringes also help to reduce soil erosion and stabilize river banks since mangrove root systems are capable of trapping soil, silt and bits of vegetation.

A systematic survey carried out in the District has concluded that there are 12 families of mangroves in the area, covering 22 species.

### Major Problem Areas

Development activities and pollution are threatening the quality of estuarine ecosystems. Of particular concern are pollutants entering the system through urban and industrial wastewater discharge, surface run-off and leaching from urban and industrial waste piles and disposal sites. The Netravathi and Gurpur Estuary is at risk due to the high density of industrial development which is planned near the Gurpur River. Other problems which could upset quality of estuarine ecosystems include run-off of nutrients and pesticides from upstream agricultural activities, siltation from soil erosion and an excessive duration of a saline environment which results from decreased continuity of freshwater flow created by deforestation and over-extraction of ground water in upstream areas.

A mangrove survey for the District has found that the most degraded mangrove sites are located in the Netravathi-Gurpur Estuary, the Mulki-Pavanje Complex and the Swarna-Sita Complex. There appears to be a strong correlation between the degraded quality of mangrove areas and proximity to urban, rural and industrial develop-



*Heavy cutting of mangroves leads to degradation of estuarine areas.*

ment. Mangrove habitats are being destroyed by coir retting, agricultural and urban encroachment, coastal and riverbank mining and unregulated mariculture.

## Long-term Objectives

To ensure sustainable development for the estuaries and the mangroves, the following long-term objectives and the following interventions, which will ensure the achievement of these objectives, are proposed.

"Diversified and well-functioning ecosystems in the major estuarine areas."

## Indicators

- Oxygen saturation percentage (bottom and surface).
- Nutrient levels.
- Occurrence of algae blooms (frequency, biomass, species composition).
- Bottom fauna index and biomass;
- "Toxicity index".
- Extent of mangrove areas.

## Interventions

I 1:  Water Resources Monitoring and Management
I 5:  Coastal Zone Monitoring and Management
I 6:  Fish Resources Monitoring and Manangement
I 7:  Biodiversity Conservation and Management
I 9:  Upgrading of Urban Sewerage and Drinking Water System
I 10: Environmental Impact Assessment Guidelines for Industries and Development Projects
I 13: Pollution Control Monitoring and Management.
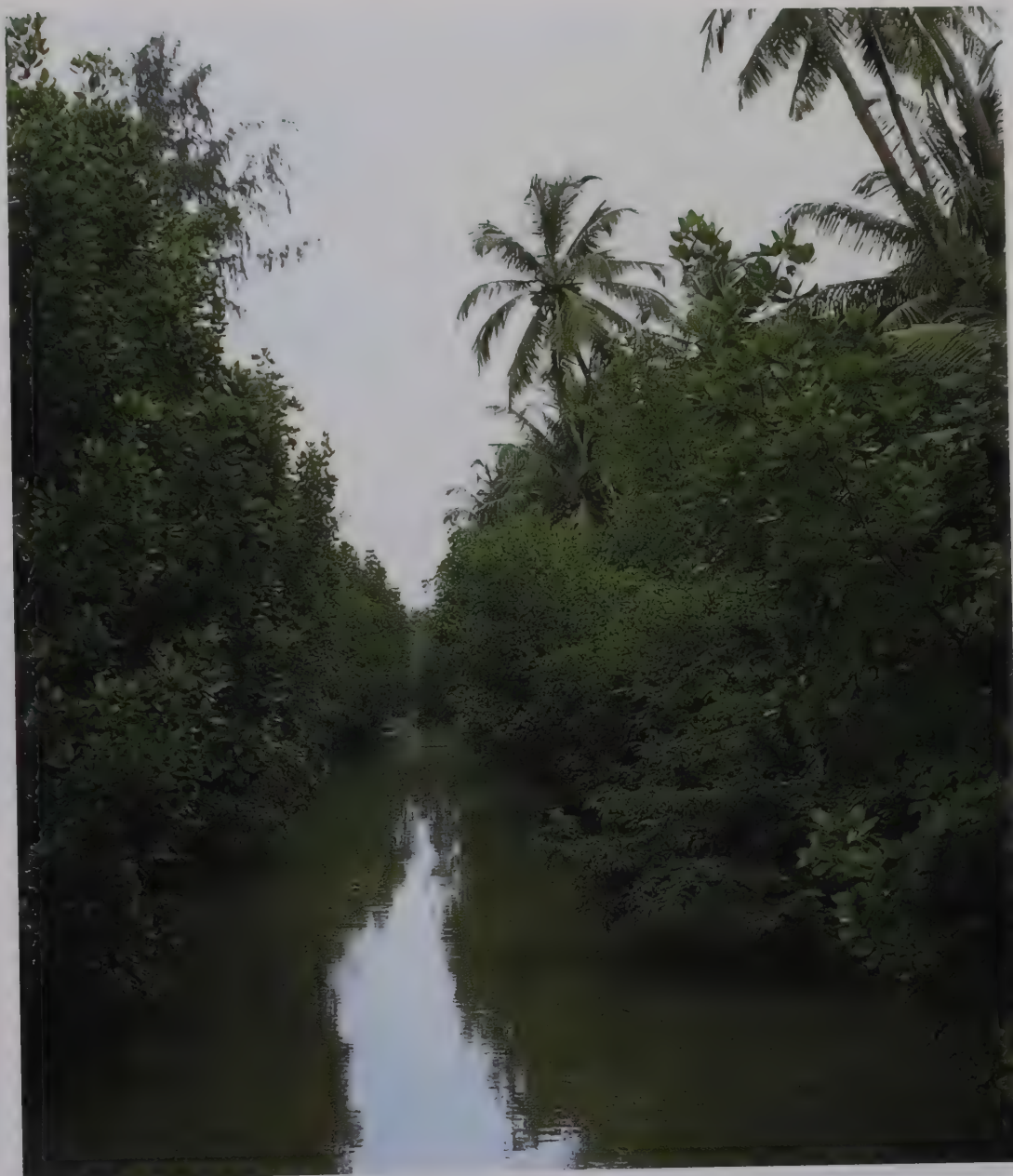


*Good quality mangrove forests should be preserved.*



*The biodiversity of the estuaries also provide recreative areas.*

# State of Natural Resources and Ecosystems

## Fish

### Present Situation

The District's fishing industry accounts for about 72% of the State's total marine fish production. The Exclusive Economic Zone of the District encompasses an area of about 43,500 km², with an estimated fishery potential ranging from 270,000 to 300,000 tonnes. The annual catchable potential in the inshore waters up to 50 m depth is estimated at just under 200,000 tonnes. Oil sardines and mackerels are the most important fish species in terms of abundance of stock, while prawns contribute the maximum to the value of the total landings and to foreign exchange earning from the export of marine products.

Annual fish landings in the District have increased significantly from about 60,000 tonnes in the mid-seventies to an average of about 143,000 tonnes during the last four years.

### Major Problem Areas

The total fish landings have been stagnant in recent years and there have been fears about serious over-exploitation. A comparison of fish landings and estimated catchable potentials in 0-50 m depth zone reveals that most of the species are almost fully exploited, and any increase in fishing pressure would lead to depletion of their stocks. Oil sardines and mackerels, the two most important species, have

| Group of Fishes | Estimated catchable potential in 0-50 m depth zone (tonnes) | Average landings 1990/91-1993/94 (tonnes) | Remarks |
| --- | --- | --- | --- |
| Elasmobranches | 1,129 | 724 | Below MSY |
| Oil sardine | 43,014 | 12,685 | Decline due to fishery independent factors |
| Other sardines | 3,940 | 5,617 | Overexploited |
| Mackerel | 40,191 | 22,159 | Decline due to fishery independent factors; signs of recovery |
| Seer fish | 2,192 | 1,784 | Below MSY |
| Tuna | 4,420 | 5,386 | Inshore waters fully exploited, more resource beyond 50 m |
| Pomfrets | 1,419 | 2,917 | Seriously overexploited |
| Catfishes | 4,717 | 672 | Overexploited |
| Flatfishes | 5,925 | 10,169 | Overexploited |
| Whitebaits | 13,763 | 6,870 | Below MSY |
| Perches | 4,011 | 2,832 | Below MSY |
| Lizard fishes | 2,006 | 1,505 | Around MSY |
| Ribbon fishes | 3,997 | 3,884 | Around MSY |
| Carrangids | 5,989 | 7,414 | Around MSY; more resources beyond 50 m |
| Prawns | 6,140 | 4,352 | Around MSY |
| Cephalopods | 1,471 | 2,870 | Overexploited |

*Estimated annual catchable potential (in 0-50 m depth zone) and average landings of marine species in Dakshina Kannada.* Sources: Department of Fisheries. CMFRI. *Abbreviation: MSY - Maximum Sustainable Yield.*

declined sharply apparently due to environmental factors. Further, the catch per unit of effort, which is an indicator of sustainability of fishing operations, has shown a declining trend in the case of mechanized boats. It is, therefore, urgently necessary to regulate the fishing industry and prevent environmental degradation. Promulgation of needed regulations and strict enforcement is called for.

## Long-term Objectives

To ensure sustainable development of fish resources, the following long-term objectives and the following interventions, which will ensure the achievement of these objectives, are proposed.

"No net depletion of exploitable stocks of commercially important finfish and shellfish."

## Indicators

- Annual catch in district waters of 10 main species.
- Catch per unit effort by various gears.
- Fishing intensity (total no. of efforts).
- Mean size of main commercial species caught.

## Interventions

I 6: Fish Resources Monitoring and Management
I 9: Upgrading of Urban Sewerage and Drinking Water System
I 10: Environmental Impact Assessment Guidelines for Industries and Development Projects
I 13: Pollution Control Monitoring and Management.



*Fish market.*



*It is estimated that the fisheries resources of Dakshina Kannada are presently fully exploited in the inshore waters.*

## River Ecosystems

### Present State

River flow, bottom characteristics, temperature patterns, nutrient concentrations, etc. all influence the state of river ecosystems. If any of these parameters are upset due to development activities, then complex interactions and important life support relationships within an ecosystem could be disrupted and life support functions adversely and irreversibly impacted upon.

Data on the quality of river ecosystems in the District are scarce. Some industrial effluents are indirectly discharged into the Gurpur River, and some limited monitoring and testing have indicated degradation of water quality during the non-monsoon period. No water quality data are available at the points where domestic wastewaters from the Mangalore urban area are discharged into the Netravathi and Gurpur Rivers.

### Major Problem Areas

The large-scale polluting industries planned for the Mangalore area will mostly be located within the Gurpur River catchment area in the vicinity where there is already considerable industrial activity. Even if these industries operate according to regulatory norms for pollution discharge, it is still highly possible that the Gurpur River could be contaminated by pollutants from spills, leaks, surface run-off, and leachate from waste and storage piles. Oil and grease, suspended particles, cyanide, arsenic, and a variety of heavy metals are typical pollutants for the types of industries that are planned for the Mangalore area. All these pollutants are harmful to aquatic life, while heavy metals have the potential to bio-accumulate through the food chain.

Soil erosion due to deforestation and inappropriate farming practices may increase sediment transport in the rivers which in turn could negatively impact ecosystems. Excess sediment can reduce water transparency, disturb fish breeding, alter bottom sediments and reduce biodiversity.

### Long-Term Objectives

To ensure sustainable development of river ecosystems, the following long-term objectives and the following interventions, which will ensure the achievement of these objectives, are proposed.

"Diversified and well-functioning ecosystems for all major river systems."

### Indicators

- Nutrient concentrations (Total-N; $NO_3$; $NH_4$; Total-P; $PO_4$).
- Diurnal minimum of oxygen concentration.
- Biochemical Oxygen Demand (BOD).
- Bottom fauna index and biomass;
- "Toxicity index".
- Water flow at selected locations in the major rivers during different periods; and for the duration of the draught period.

### Interventions

I 1:  Water Resources Monitoring and Management
I 7:  Biodiversity Conservation and Management
I 8:  Solid Waste Management
I 9:  Upgrading of Urban Sewerage and Drinking Water System
I 10: Environmental Impact Assessment Guidelines for Industries and Development Projects
I 13: Pollution Control Monitoring and Management.



*The quality of the river ecosystems should be monitored and the rich biodiversity should be conserved.*

# State of Natural Resources and Ecosystems

## Air

### Present Quality and Trends

Data on air pollution in the District are scarce and fragmental. The types of air pollutants being discharged in Dakshina Kannada include suspended particulate matter (SPM), sulphur dioxide ($SO_2$), nitrogen oxides ($NO_x$), hydrocarbons, carbon monoxide (CO) and lead (Pb).

Using air dispersion models, it has been found that the present $NO_x$ concentrations in specific parts of the Mangalore urban area exceed ambient air quality levels set by the Government. This is due to the vehicular traffic.

### Present and Projected Pollution Load

Based on Karnataka State Pollution Control Board (KSPCB) data and other calculations, the total air pollution load in the District is approximately 19 tonnes per day of SPM, 19 tonnes per day of $SO_2$, and 9 tonnes per day of $NO_x$. Large and medium-scale industries emit most of the $SO_2$ and SPM, while motor vehicles collectively are the biggest dischargers of $NO_x$. Air pollution emissions are expected to significantly increase after operations commence at several large-scale industries planned for the Mangalore area. In addition, a few existing large-scale industries plan to greatly expand production. Based on this future industrial development scenario for the District, it is estimated that air pollution emissions may increase by factors about 10 by 2002.

### Future Quality

Since most of the new large-scale industries are planned for Manga-
lore Taluk, air quality in this region needs to be carefully studied in the future. Apart from local areas close to industries, which have not been investigated, air dispersion model calculations have shown that the ambient air quality standards for $SO_2$ and SPM are not expected to be exceeded due to the existing and planned high industrial stacks. The ambient air quality standard for $NO_2$, however, is expected to be substantially exceeded in the Mangalore urban area due to the future vehicular emissions from the fast growing traffic.

### Major Problem Areas

Air as a natural resource could be adversely affected in the future if appropriate monitoring, pollution prevention and control technologies, adequate industrial stack heights and planning procedures are not implemented. The possible effects of acid rain on the fragile vegetation, biodiversity and soils of the Western Ghats also need to be assessed. Also impacts of air pollution on human health particularly in Mangalore City should be monitored closely.

### Long-Term Objectives

To ensure sustainable development of air, the following long-term objectives and the following interventions, which will ensure the achievement of these objectives, are proposed.
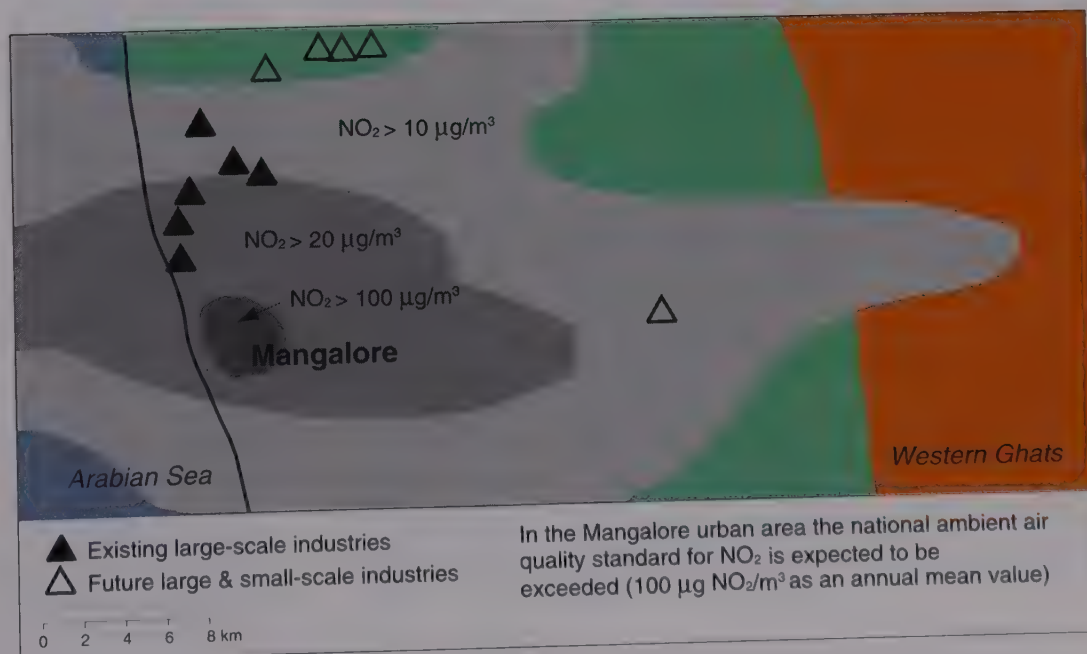
> "Ambient air quality is maintained at a level which protects human health and causes no damage to ecosystems or biodiversity."

### Indicators

Ambient air quality concentrations such as $SO_2$, $NO_2$, SPM, lead and carbon monoxide measured at specified sampling locations not to exceed the current national standards.

### Interventions

I 2:   Air Pollution Monitoring and Modelling
I 10:  Environmental Impact Assessment Guidelines for Industries and Development Projects
I 11:  Environmental Management Plan for Energy
I 12:  Environmental Management Plan for Traffic.



In the Mangalore urban area the national ambient air quality standard for $NO_2$ is expected to be exceeded (100 µg $NO_2$/m³ as an annual mean value)

▲ Existing large-scale industries
△ Future large & small-scale industries

0  2  4  6  8 km

*Future air quality for nitrogen dioxide in Dakshina Kannada District.*

## Minerals

### Present Stock and Annual Exploitation

Significant reserves of minerals are found at several locations within the District. These include iron ore, bauxite, lime shell, magnetite quartzite, silica sand, banded granitic gneiss, laterite and sand. In terms of quantities extracted, ordinary sand, building stones (banded granitic gneiss) and laterite are the three most important minerals.

Iron ore is not being mined due to low iron content, and bauxite mining leases are not operational because of unfavourable market conditions. Total value of mineral production in the District is Rs 15 million (1992/93 prices).

### Major Problem Areas

Since present mineral extraction is low, current mining operations appear to be sustainable and not an immediate threat to the District. In the future, iron ore and bauxite mines could be established, if the mineral market improves. In this event, the implications for the long-term management of mineral resources would have to be re-evaluated.

### Long-term Objectives

To ensure sustainable development of minimal resources, the following long-term objective is proposed.

"Mineral resource conservation practices are observed, and extraction is undertaken resulting in minimum environmental damages."

### Indicators

Annual extraction as a percentage of the estimated total stock for each mineral.

### Interventions

As mineral extractions are currently small, no immediate interventions are suggested. If the bauxite and iron ore mining leases are exercised in the future, then environmental impacts can be minimized by controlling silt erosion from mine spoils and introducing revegetation measures, etc.
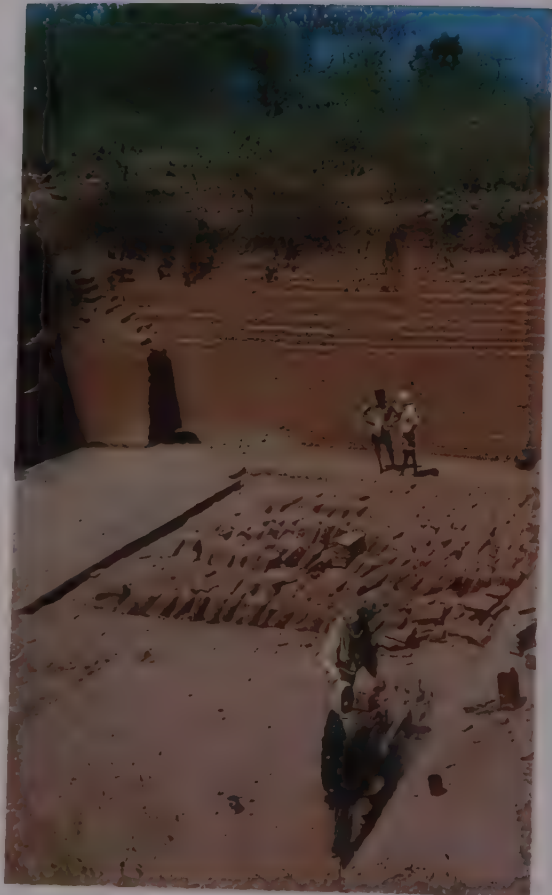
*Building stones are the most important mineral in terms of annual production.*

| Mineral | Reserve Qty '000MT | Number of Leases | Lease Area (ha) | Annual Production '000MT | Annual Production as % of Reserve |
|---|---|---|---|---|---|
| Iron ore | 1187 | 0 | 0 | 0 | 0 |
| Bauxite | 2555 | (1 leaseholder) | 0 | 0 | 0 |
| Lime Shell | 500 | NA | 61 | 1-3 | 0.6 |
| Magnetite Quartzites | 8000 | 0 | 0 | 0 | 0 |
| Silica Sand | 1500 | Na | 124 | 12 | 0.8 |
| Building stone (banded granite gneisses) | N/A | 592 | 194 | 60 | ~ 0 |
| Laterite | N/A | 57 | 14 | 16 | ~ 0 |
| Ordinary Sand | N/A | 82 | 42 | 106 | ~ 0 |

*Stock and annual extraction of minerals.*
Sources: Dept. of Mines & Geology, 1993, Various Geological Studies, Karnataka State Gazetteer, 1971.

## Major Future Problem Areas

Based on an assessment of the present state of natural resources and ecosystems and on the impact arising from the projected development trends, it is possible to assess to what degree each of the natural resources and ecosystems will be threatened or damaged. Three categories are defined with regard to describing current and future pressure on the resources and ecosystems. These categories consist of Low Pressure, Moderate Pressure and High Pressure.

Natural resources which are already under threat and which are expected to be under high pressure in the future include agricultural lands, common lands and reserved forests. Other natural resources which will be threatened include the stock of certain species of fish in shallow coastal waters, the Gurpur River water quality near the industrial areas, ground water quality and quantity in various taluks, and air quality in Mangalore. The ecosystems of the Western Ghats are expected to be under high pressure in the future as well as the mangrove and estuary ecosystems neighbouring the Netravathi, Gurpur, Swana, Sita and Kodi Hole rivers.

Under the EMP, the most immediate interventions will be targeted towards improving the availability or condition of the natural resources and ecosystems within the High Pressure and Medium Pressure categories.

| NR & ES | Low Pressure | Moderate Pressure | High Pressure |
|---|---|---|---|
| **Agricultural Land** | | | |
| Quantity | | X | O |
| Quality | | X | O |
| **Forest** | | | |
| Quantity | XO | | |
| Quality | | X | O |
| **Common Land** | | | |
| Quantity | | | XO |
| Quality (biomass) | | X | O |
| **Fish (0 - 50 metres)** | | | |
| Quantity | | | |
| Oil sardine | | XO | |
| Mackerel | | | XO |
| Tuna | | | XO |
| Pomfret | | | XO |
| Anchovy | | | XO |
| Prawn | | XO | |
| **Fish ( >50 metres)** | | | |
| Quantity | XO | | |
| **Surface Water** | | | |
| Quantity of Rivers | | | |
| During February, March, April, May where river flow is close to nil | | | XO |
| During June to January | XO | | |
| Quality of Rivers | | | |
| Netravathi (at certain specific sites) | X | O | |
| Gurpur (close to industrial sites) | | | XO |
| Local streams in Mangalore area | | | XO |
| Other Rivers | XO | | |

| NR & ES | Low Pressure | Moderate Pressure | High Pressure |
|---|---|---|---|
| **Ground Water** | | | |
| Quantity | | | |
| Kundapur | X | O | |
| Bethangady | X | O | |
| Karkala | X | O | |
| Puttur | X | O | |
| Udupi | X | O | |
| Bantwai | | X | O |
| Mangalore | | X | O |
| Sullia | | X | O |
| Quality | | | |
| Malpe area | | X | O |
| Gurpur area | | X | O |
| Coastal (general) | | X | O |
| Other areas | XO | | |
| **Air** | | | |
| NO$_x$ | | | |
| Mangalore taluk | | X | O |
| Bantwal taluk | X | O | |
| All taluks | X | O | |
| SO2 | | | |
| All taluks | X | O | |
| SPM | | | |
| Mangalore taluk | X | O | |
| All taluks | XO | | |
| **Western Ghats ES** | | | XO |
| **River ES** | | | |
| General | XO | | |
| By location in Magalore area | | | XO |
| **Estuaries and Mangrove ES** | | | |
| Estuaries | | | |
| general water quality | X | O | |
| Mangroves | | | |
| Netravathi and Gurpur | | | XO |
| Mulki and Pavanje | | XO | |
| Udyavar/Pangala | | XO | |
| Swarna/Sita /Kodi Hole | | | XO |
| Chakara/Haladi /Kollur | | XO | |
| Baindur Hole /Shirur Hole | XO | | |
| **Coastal Water ES** | X | O | |

*Identification of major current (X) and future (O) (year 2002) problem areas related to natural resources and ecosystems.*

# Institutions and the Environment

### Institutional Framework

An important objective of the EMPS is to increase the capacity of the involved institutions through trained manpower, management systems and awareness.

Increased capacity also includes the ability to review and update the EMP and to implement interventions arising from the EMP.

### Capacity to Review and Update the EMP

#### Key Issues

Key issues regarding the capacity to review the EMP are:

• At present, there is no single agency responsible for integrated environmental planning at the district level.

• There is a number of district institutions functioning independently of each other and governed by policies laid down at the state and central government levels.

• Decisions on locating large projects in Dakshina Kannada are essentially taken outside the District.

**Some Implications of the Karnataka Panchayat Raj Act, 1993**
Section 310(1) of the Act stipulates the formation of a District Planning Committee for the preparation of an Integrated Development Plan for the District. Section 310(7) mandates the incorporation of environmental considerations in preparation of the Draft Development Plan for the District:

"Every District Planning Committee shall, in preparing the draft development plan, have regard to:

The matters of common interest between the Zilla Panchayats, Taluk Panchayats, Grama Panchayats, Nagara Panchayats, Municipal Corporations and Municipal Councils in the District. These include spatial planning, sharing of water and other natural resources, the integrated development of infrastructures and environmental conservation.

The extent and type of available resources whether financial or otherwise."

The Karnataka Panchayat Raj Act, 1993 is an important tool in strengthening environmental planning at district level.

### Capacity of Individual Institutions to Implement Proposed Interventions

In many cases, the implementation of an intervention is the responsibility of two or more institutions. In these cases, sharing of responsibility between institutions is necessary.

Many interventions are outside the implementing institution's routine activities. This requires new knowledge, skills and attitudes of the staff involved.

Most institutions are used to giving high priority to achieving traditional development targets, whereas environmental consideration in implementing programmes and schemes has been given low priority.

Other constraints leading to a lack of environmental focus include:
• weak enforcement of existing environmental acts and regulations;

• organizational set-ups of institutions which do not encourage environmental consideration;
• lack of trained professionals;
• lack of technical facilities; and
• lack of funds.

### Interventions

To strengthen the institutions so they are able to ensure sustainable development in the District, two main interventions are proposed:

I 20: Strengthening Procedures and Systems for Integrated Environmental Management
I 21: Comprehensive Training Programmes for Staff of Institutions Implementing the EMP Interventions.

**Strengthening Procedures and Systems**
The organizational framework proposed consists of:

• An EMP monitoring cell in the Department of Forest, Ecology and Environment (DFEE) at state level
• District Environmental Committee (DEC)
• District office of the DFEE to function as a secretariat for the DEC
• District environmental working groups
• Taluk environmental working groups
• Grama Panchayat environmental working groups.

In the proposal, the DEC has the overall responsibility for the preparation and monitoring of the EMP. The EMP should be approved and ratified by the DFEE at the State level. The DFEE would also facilitate coordination with various departments at the

state level as well as with the Ministry of Environment and Forests at the central level. District environmental working groups may be established by the DEC to be responsible for detailed planning, coordination of implementation and monitoring of their respective interventions.

The District office of the DFEE acts as the secretariat to the DEC and coordinates the functioning of different working groups. The Grama Panchayat environmental working groups are responsible for village level interventions. These are consolidated by the taluk environmental working groups.

The EMP approved by the DEC is envisaged to be incorporated into the Integrated District Development Plan. In accordance with the Karnataka Panchayat Raj Act, 1993, this would be the responsibility of the District Planning Committee. It is envisaged that the EMP process is implemented with a high degree of public participation. It is consequently proposed that DEC meetings are open to the press and public hearings are arranged before the EMP and other plans are fully approved. The public should be given the possibility of making written comments to the plans after the hearings. Relevant comments should be taken into consideration when preparaing the EMP and action plans.

**Comprehensive Training Programmes**
The staff of institutions and agencies involved in implementing the various EMPS interventions, apart from being committed, must be qualified to perform the necessary functions. This will require learning of new skills and developing a new awareness within a large number of sectors. The staff need to be oriented towards expanding responsibility. Consequently, a comprehensive need-based training programme is proposed.
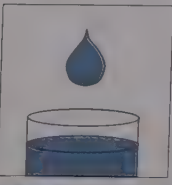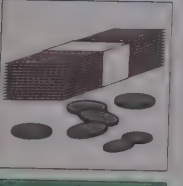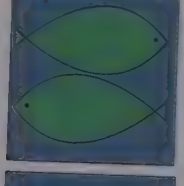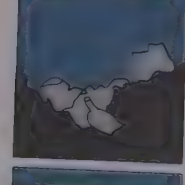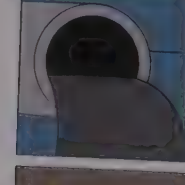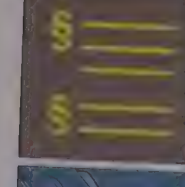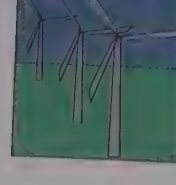
All institutions responsible for implementation of the EMP interventions will be involved, including non-governmental organizations.
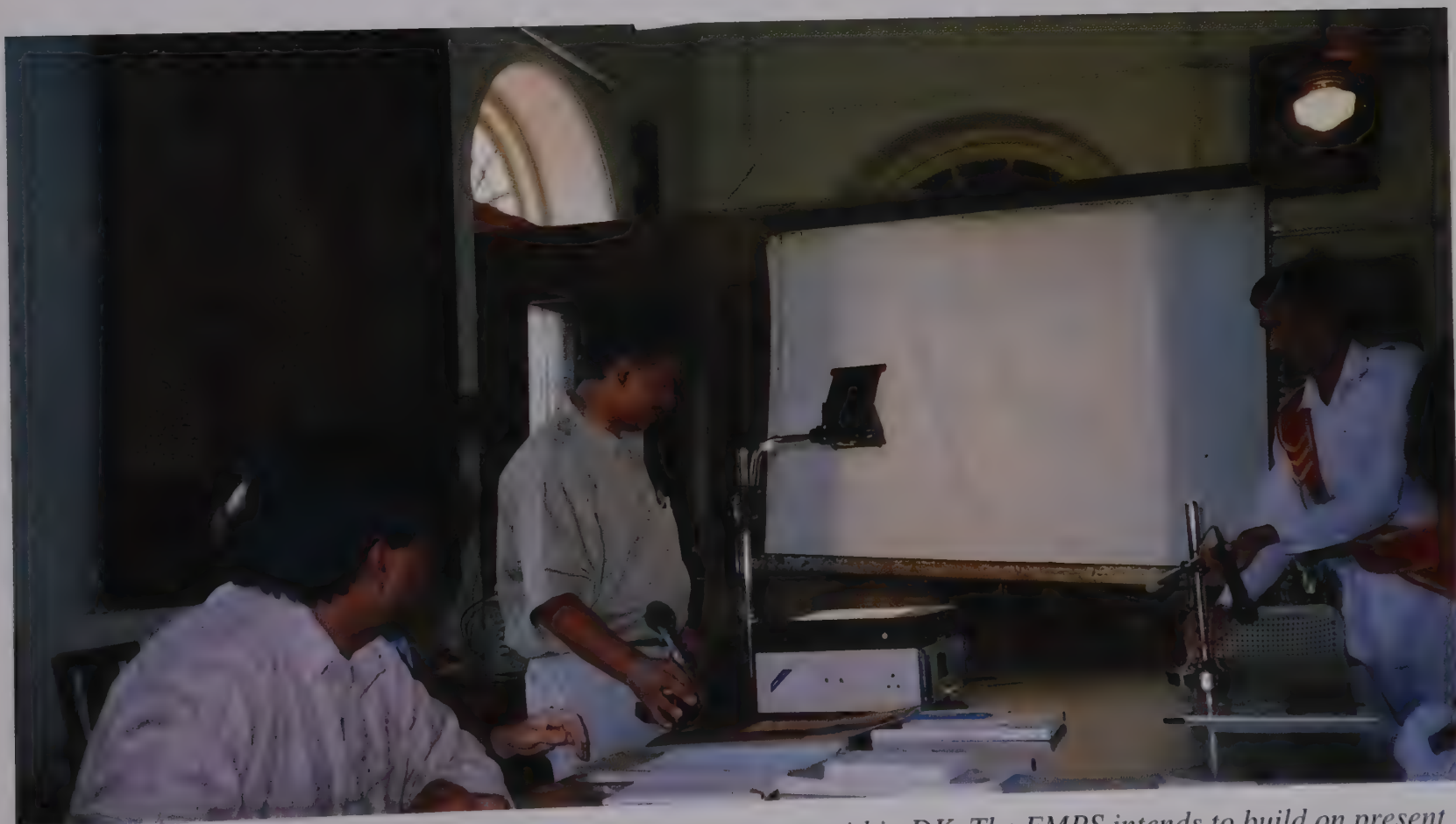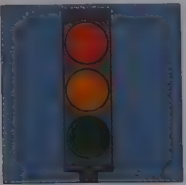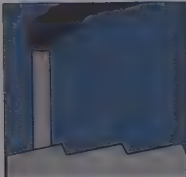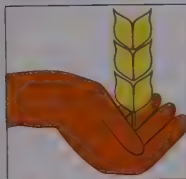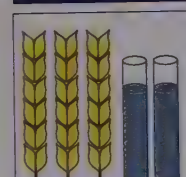


*The potential for successful environmental management exists within DK. The EMPS intends to build on present strengths and develop required capacity to promote proper management.*

# Interventions

## Summary of Proposed Interventions

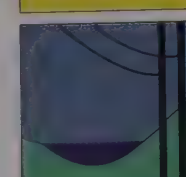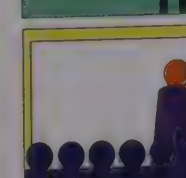| No. | Intervention | Objectives and Scope of Activities | Main Institutions Involved |
|---|---|---|---|
| I 1 | Water Resources Monitoring and Management | Surface and ground water are available in adequate quantities and quality for human activities. Quality and quantity of surface water and ground water will be monitored. Identification of possible water related problems should lead to correction activities. | Dept. of Mines & Geology, CGWB, CWC, WRDO, KSPCB, Irrigation Dept., KREC, College of Fisheries, and Mangalore University. |
| I 2 | Air Pollution Monitoring and Modelling | Ambient air quality standards are maintained for all areas of the District at all times of the year, and fragile ecosystems are protected. An air monitoring system will be established including an ambient air quality data base and a model predicting air pollution concentrations. | KSPCB, KREC and industries. |
| I 3 | Introduction of Economic Instruments in Conserving Natural Resources and Ecosystems | More specific economic policy measures are employed to mitigate negative effects or enhance positive effects of existing policies on preservation of natural resources and ecosystems. The instruments could include changes in user charges for water and energy, imposition of pollution taxes and different subsidies. | DFEE, Dept./Ministry of Finance, local institutions, etc. |
| I 4 | District Land Use Plan (DLUP) | Land is put to optimum use in terms of protecting natural resources and ecosystems, while maintaining socio-economic goals. A district land use map based on capability of the land and long-term requirements of land for various purposes will be proposed including implementation strategy. | Zilla Panchayat, MUDA, MCC, Dept. of Agriculture, KIADB, KUWSDB, KSPCB, Forest Dept, and Deputy Commissioner. |
| I 5 | Coastal Zone Monitoring and Management | The Coastal Zone is managed towards minimizing losses due to erosion. Erosion-prone areas will be identified and monitored and appropriate measures will be suggested including protection methods. | Zilla Panchayat, Dept. of Agriculture, Ports & Harbour Dept., KREC and other research organizations. |
| I 6 | Monitoring and Management of Marine Fish Resources | The exploitable stocks of commercially important fin and shell fishes are not depleted. The monitoring programme will include base line studies and review of existing procedures for stock assessment. The management plan will include legal regulation, fishing zones, licensing and registration, and catch regulation. | Ministry of Fisheries, DFEE and College of Fisheries. |
| I 7 | Biodiversity Conservation and Management | Biodiversity is conserved and ecosystems are maintained and well-functioning. Plans for Western Ghats will contain net working of protected areas and biosphere reserves and model management plan. A database on quality and quantity of aquatic ecosystems will be set up and threatened species will be protected. | DFEE, Forest Dept. and Revenue Dept. |
| I 8 | Solid Waste Management | All forms of solid waste generated in the District, including infectious and hazardous wastes, are managed in a manner that does not degrade the quality of surface and ground water and presents no significant threats to the health of the public and sanitation workers. The system should be financially self-sustainable. | MCC, Udupi Municipality, KSPCB, hospitals and industries. |
| I 9 | Upgrading of Urban Sewerage and Drinking Water System | The quality of water supplied to the residents of Mangalore and Udupi is in compliance with drinking water standards. A well-functioning sewerage collection and treatment system is in operation covering the entire Mangalore urban area. Ground water, local wells, and surface waters are not contaminated by sewage. | MCC, KREC, KUWSDB, Udupi Municipality. |
| I 10 | Environmental Impact Assessment Guidelines for Industries and Development Projects | EIA is used as an integral part of development planning and decision-making in the District in an open, participatory process in which district and local agencies and the public are actively involved. The EIA process is a prime tool for ensuring achievement of the long-term sustainable development objectives for natural resources and ecosystems in the District. | DFEE, KSPCB, KUWSDB, MUDA, KIADB, municipalities, universities and research institutions, local NGOs and citizen groups. |
| I 11 | Environmental Management Plan for Energy | The energy deficit within the District is eliminated, air quality standards are maintained, and degradation of reserved forests and common lands is reduced. An energy conservation programme will be prepared including viable energy sources and utilization practices. | DFEE, KEB, industries, Grama Panchayat, Dept. of Non-Conventional Energy Sources, etc. |

| No. | Intervention | Objectives and Scope of Activities | Main Institutions Involved |
|---|---|---|---|
| I 12 | Environmental Management Plan for Traffic in the Mangalore Area | Within the Mangalore area, traffic is effectively managed to the extent that traffic congestions are infrequent, local concentrations of air pollutants remain below health thresholds, and the probability of serious road accidents is significantly decreased. | Police Dept., MCC, Regional Transport Office, MUDA, local NGOs, Chamber of Commerce and Industry. |
| I 13 | Pollution Control Monitoring and Management | Within the District, industrial waste generation and discharge of pollutants to the environment are reduced to a degree that is economically and technologically feasible and that contributes to the attainment of the long-term sustainable development objectives for natural resources and ecosystems in the District. | DFEE, KSPCB, Fire Dept., Police Dept., industries, the New Mangalore Port Trust, the Coast Guard and local citizens groups. |
| I 14 | Plan for Participatory Management of Common Lands and Forests | For common lands and forests, a non-declining supply of biomass is maintained coupled with a reduction in soil erosion and maintenance of biodiversity. The intervention will involve pilot projects for user management of non-wood forest products and for common lands. | Zilla Panchayat, specifically the Social Forestry Division. Also Forest Dept. and local NGOS |
| I 15 | Strategies for Improved Agricultural Practices | The sustainable use of agricultural land in terms of maintaining long-term productivity through the development and diffusion of a portfolio of appropriate agricultural practices. This includes strategies for production and use of green manure, protecting soil from erosion and nutrient depletion and integrated pest management. | Zilla Panchayat. |
| I 16 | Public Awareness and Participation | The public participates in the decision-making process for natural resources utilization and conservation and is aware of proper utilization and conservation of natural resources and ecosystems. Information campaigns and procedures for obtaining public opinion on large projectsc are included. | DFEE, Zilla Panchayat, MCC, MUDA and the NGO groups. |
| I 17 | Promoting Environmental Aspects in Agricultural Research | Sustainable use of the natural resources and ecosystems on which agriculture depends for its productivity is promoted by giving sustainability a high priority in the agricultural research programme. A long-term strategy will be prepared and implementation included. | Dept. of Agriculture, Agricultural Research Institutes and Agricultural Universities. |
| I 18 | Conservation and Management of Agricultural Biodiversity | Agricultural biodiversity is preserved in Dakshina Kannada and awareness of agri-biodiversity is increased. The intervention will include living collections of agricultural plants and expanded collections of local plant germ plasm. | Dept. of Agriculture, National Bureau of Plant Genetic Resources, University of Agricultural Science and farmer groups. |
| I 19 | Strategies for Strengthening Occupational Health and Safety | Improved working conditions in all industrial sectors with the additional benefit of reducing waste discharge to the environment. Management guidelines including priorities and preventive measures will be prepared and implemented. A registration system will be set up. | District Labour Office, District Health Office, District Inspectorate of Factories, and KSPCB. |
| I 20 | Strengthening Procedures and Systems for Integrated Environmental Management | Systems and procedures for integrated environmental management are established in the District, and agencies and institutions are strengthened to support implementation. An institutional development programme will be set up and implemented including an environmental data base and a management information system. | All institutions involved in implementation of the EMP interventions. |
| I 21 | Comprehensive Training Programmes for Staff of Institutions Implementing the EMP Interventions | The institutions and agencies have capacity to implement the EMP interventions. A comprehensive training programme for training staff of all institutions participating in implementing the EMP interventions will be conducted. | All institutions involved in implementation of the EMP interventions. |

# Interventions

## and their Linkages to Natural Resources/Ecosystems

Only major linkages have been shown

| Intervention | Agricultural Land | Forest and Common Land | Minerals | Fish | Surface Water | Ground Water | Air | Western Ghats | River | Estuaries/Mangroves | Coastal Water | Health (incl. Occupational Safety and Quality of Life) | Social/Gender Issues |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 Water Resources Monitoring and Management | X | X | | | X | X | | | | | | | |
| 2 Air Pollution Monitoring and Modelling | | | | | | | X | | | | | | |
| 3 Introduction of Economic Instruments in Conserving Natural Resources and Ecosystems | X | X | | X | X | X | X | | | | | | |
| 4 District Land Use Plan (DLUP) | X | X | | | | | | | | | | | |
| 5 Environmental Management for Coastal Areas | | X | | | | | | | | | X | | |
| 6 Fish Resources Monitoring and Management | | | | X | | | | | | | | | |
| 7 Biodiversity Conservation and Management | | | | | | | | X | X | X | X | | |
| 8 Solid Waste Management | | | | | X | X | | | | | | X | |
| 9 Upgrading of Urban Sewerage and Drinking Water System | | | | | X | X | | | | | | X | |
| 10 Environmental Impact Assessment Guidelines for Industries and Development Project Schemes | X | X | | X | X | X | X | X | X | X | X | | X |
| 11 Environmental Management Plan for Energy | | X | | | X | | X | | | | | X | X |
| 12 Environmental Management Plan for Traffic in the Mangalore Area | | | | | | | X | | | | | X | |
| 13 Pollution Control Monitoring and Management | | | | X | X | X | X | X | X | X | X | X | |
| 14 Plan for participatory Management of Common Lands and Forests | X | X | | | | | | | | | | | X |
| 15 Strategies for Improved Agricultural Practices | X | X | | | X | X | | | | | | | |
| 16 Increased Public Awareness and Involvement in Environmental Issues | X | X | X | X | X | X | X | X | X | X | X | X | X |
| 17 Promoting Environmental Aspects in Agricultural Research | X | X | | | | | | | | | | | |
| 18 Conservation and Management of Agricultural Biodiversity | X | X | | | | | | | | | | | |
| 19 Strategies for Strengthening Occupation Health and Safety | | | | | | | | | | | | X | |
| 20 Strengthening Procedures and Systems for Integrated Environmental Management (including establishment of a District body and strengthening of a monitoring body at DEE) | X | X | | X | X | X | X | X | X | X | X | | |
| 21 Comprehensive Training Programmes for Staff of Institutions Implementing the EMP Interventions | X | X | | X | X | X | X | X | X | X | X | | |

National Resource | Ecosystem | Other Aspects

# Publications

The following reports and papers are prepared as part of the Environmental Master Plan Study for Dakshina Kannada District.

## General reports:
- Project Document, (covering the first two study years), July 1993
- Summary of Status Reports, Volume I and II, September 1993
- Planning Framework Report, Revised Version, January 1994
- Environmental Profile, June 1994

## Component A: Institutional Framework
- Planning for Environmental Sustainability, August 1993
- Status Report on Institutional Framework, Volume I and II, September 1993

## Component B: Urban and Industrial Development
- Status Report on Urban & Industrial Development, September 1993
- Study on Solid Waste Management, Volume I, December 1993 and Volume II, February 1994
- Assessment of Traffic Systems in Mangalore, January 1994
- Project Document on Analysis of Mangalore Water and Sanitation System, January 1994
- Monitoring of Industrial and Domestic Pollution in Dakshina Kannada District, May 1994
- Pollution Control Management in Dakshina Kannada, May 1994
- Environmental Audits of 6 Industries in Dakshina Kannada District, Volume I - VI, April - June 1994
- Study on Occupational Health and Safety, May 1994
- Hospital Waste Management, T. Kristoffersen et al., Masters Thesis, 1994

- Study on Urban Energy, November 1994

## Component C: Rural Development
- Status Report on Rural Development, Volume I and II, September 1993
- Study on Livestock and Fodder Balance, December 1993
- Study on Agriculture, March 1994
- Study on Rural Energy, December 1994

## Component D: Economic Setting
- Status Report on Economic Environment, September 1993
- Establishment of a Human Development Index, July 1993

## Component E: Natural Resources and Ecosystems
- Status Report on Natural Resources, September 1993
- Report on Forests, September 1993
- Further Studies on Forestry, January 1994
- Study on Biodiversity, March 1994
- Study on Common Land Resources, March 1994
- Study on Soils, March 1994
- Fish Stock, Exploitation and Conservation in Coastal Water of Dakshina Kannada District, May 1994
- Study on Coastal Waters, Preliminary Findings, May 1994
- Study on River Systems and Estuaries, Preliminary Findings, May 1994
- Fringing Mangroves: Ecology and Human Impact, Naomi Elkington, Masters Thesis, June 1994
- Study on Coastal Erosion, July 1994

- Field Visits to River Gauging Stations and Observation Wells, September 1994
- Rainfall Run-off Modelling and Water Resources Assessment, September 1994
- Evaluation of Available Water Resources - Recommendations for Future Water Management, September 1994

## Component F: Social Setting
- Status Report on Social Environment, September 1993
- Women in Dakshina Kannada District, June 1994

The reports and papers which constitute the Environmental Management Plan and Action Plans for Dakshina Kannada District are shown on the next page.
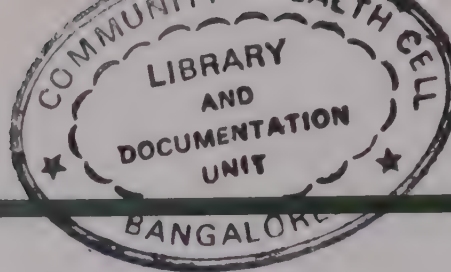
## Reports Constituting the Environmental Management Plan and Action Plans for Dakshina Kannada District

### Project Proposals and Immediately Needed Projects

| | | Other Reports |
|---|---|---|

**Project Proposal for Water Resources Monitoring and Management**

Intervention No. **1**

**Immediately Needed Project for Improvement of Mangalore Water and Sanitation System-Phase 2, and Analysis of other Urban Sanitation Systems**

Intervention No. **9**

**Immediately Needed Project for Environmental Management for Industry**

Interventions No. **2, 10 and 13**

**Project Proposal for Environmental Management Plan for Energy**

Intervention No. **11**

**Project Proposal for Introduction of Economic Instruments in Conserving Natural Resources and Ecosystems**

Intervention No. **3**

**Project Proposal for Environmental Management for Traffic**

Intervention No. **12**

**Immediately Needed Project for Land Use Plan**

Intervention No. **4**

**Project Proposal for Participatory Management of Common Lands and Forests**

Intervention No. **14**

**Environmental Profile for Dakshina Kannada District**

**Environmental Management Plan and Action Plans**

**Project Proposal for Coastal Zone Monitoring and Management**

Intervention No. **5**

**Project Proposal for Sustainable Use of Natural Resources and Ecosystems for Agricultural Production**

Interventions No. **15, 17 and 18**

**Brochure on Managing Sustainable Development**

**Project Proposal for Monitoring and Management of Marine Fishery Resources**

Intervention No. **6**

**Project Proposal for Increased Public Awareness and Involvement in Environmental Issues**

Intervention No. **16**

**Manual for Preparation of District Environmental Management Plans and Action Plans**

**Immediately Needed Project for Western Ghats Biodiversity Conservation and Management**

Intervention No. **7 (partly)**

**Project Proposal for Strengthening of Occupational Health and Safety**

Intervention No. **19**

**Project Document for Aquatic Ecosystem Monitoring and Management**

Intervention No. **7 (partly)**

**Project Proposal for Strengthening of Systems and Procedures for Integrated Environmental Management**

Intervention No. **20**

**Immediately Needed Project for Solid Waste Management**

Intervention No. **8**

**Project Proposal for Comprehensive Training Programmes**

Intervention No. **21**